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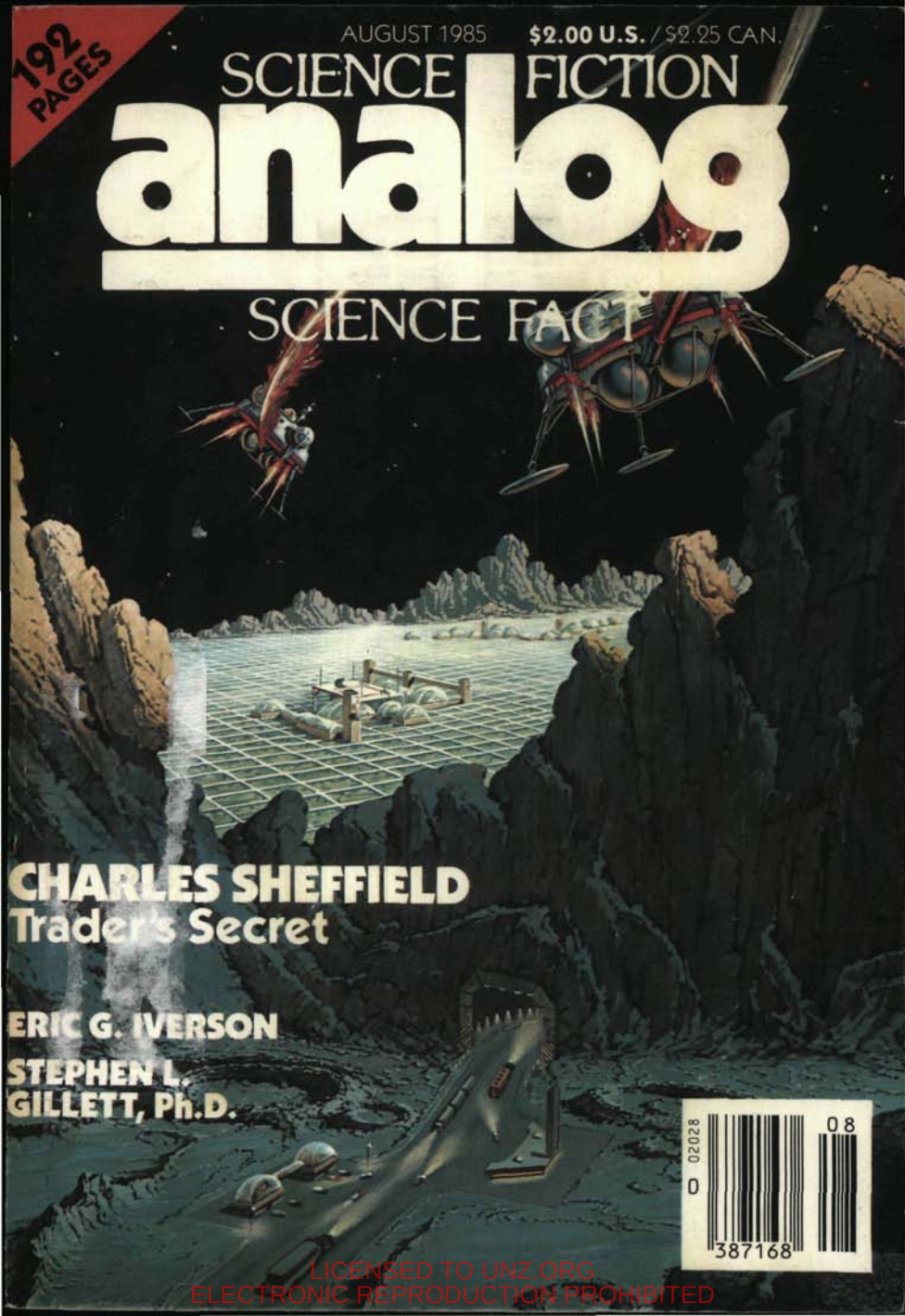

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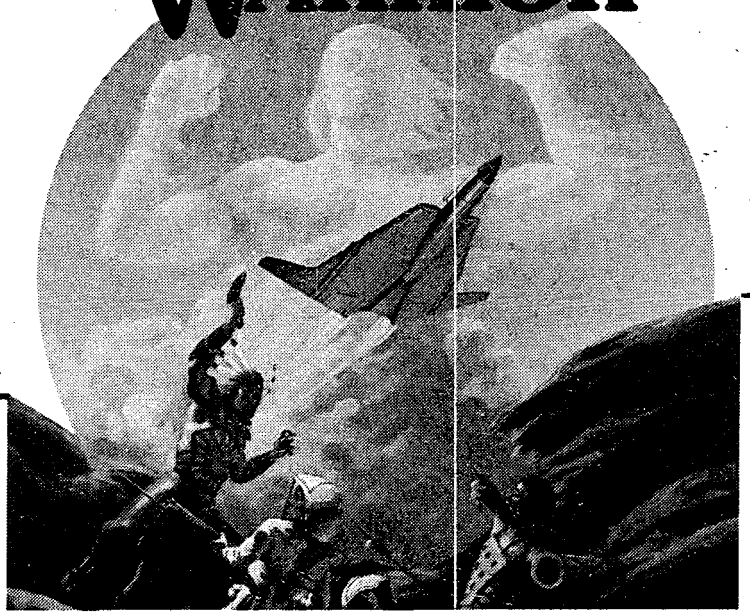

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Editorial

IN CASE OF DOUBT...

Stanley Schmidt

By now it would probably be hard to find an *Analog* reader who isn't at least casually familiar with the "nuclear winter" scenario put forth by R. P. Turco, O. B. Toon, T. P. Ackerman, J. B. Pollack, and C. Sagan (and sometimes identified by their initials, TTAPS). The essence of the theory, based on computer simulations, is that the bad effects previously known to result from a nuclear war would be overshadowed by another, not previously considered. The sheer amount of dust and smoke strewn about the atmosphere by the explosions would block out so much sunlight, for so long a period, that photosynthesis would grind to a halt, crops would fail, and whole species of animals (likely including man) would starve and/or freeze to death. Since TTAPS first published, several other groups have run similar studies, each with its own group of initial assumptions. The exact results depend on the assumptions, of course, but in general the other studies have tended to support the original thesis. If the nuclear winter effect is real, the consequences of nuclear war would be even worse than everybody knew they would be. The possibility of total extinction of our species, and incidentally numerous others, has become one of the strongest arguments of pro-

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ponents of disarmament efforts, satellite defense systems, and other measures aimed at making nuclear war impossible.

But *is* the nuclear winter effect real?

The mere fact that a calculation or a computer simulation says something will happen does *not* necessarily make it so. Even if several such studies, all carefully done by highly competent people, agree, the validity of the results still depends on the validity and completeness of the assumptions. We've been through this often enough before, with cases like "Limits to Growth," that we should be well aware of this and wary of accepting the result of *any* simulation as Unquestionable Truth. If half a dozen groups have studied the same problem and come up with essentially similar conclusions, it may simply mean that they made similar assumptions. It's quite possible that one or more of those assumptions is widely accepted but wrong, or that none of the groups has yet thought to include some variable which will turn out to have a crucial effect on the outcome. Such an omission is particularly likely when the system under discussion is as complicated as Earth's atmosphere.

So it is hardly surprising that voices of dissent began to appear soon after the phrase "nuclear winter" entered the language. A number of respectable, scientifically knowledgeable people have challenged the nuclear winter hypothesis, pointing out that weather forecasting (on *any* time scale) is still far from a precise science and that volcanic eruptions have been known to spew large amounts of dust into the atmosphere without producing effects anywhere near as drastic as those predicted for a nuclear war. Some of these have gone on to hint that if the nuclear winter scenario is, as they suspect, invalid, than the objections to nuclear weapons are not as strong as the current fashion assumes. If a nuclear war would *not* lead to extinction, then maybe it is an acceptable option under some circumstances.

I don't know how many of the nuclear winter doubters have done detailed simulations of their own. Most of the arguments I've seen have been largely "hand-waving," relying on qualitative or semiquantitative analogies with historical events like the Krakatoa eruption and the "year without a summer" following the 1815 eruption of Tambora (which, obviously, did not cause extinction). Since atmospheric phenomena are so complex, such an argument, supported by little more than a back-of-the-envelope calculation involving a few pertinent but selected numbers, is even less to be trusted than a competent computer simulation. Furthermore, TTAPS specifically addressed the similarities and differences between nuclear war and volcanic effects.

But even if some of the critics *have* done high-quality simulations to reach their conclusions, does that fact justify a return to the acceptance of nuclear weaponry as an option for use? As a potential victim, I have doubts. Even if it is possible for a significant fraction of humanity to survive a nuclear war, and nuclear winter would be milder than most studies indicate, the other effects

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are quite enough that I have no desire to be subjected to them. But that is not the real issue. The issue is that nobody really *knows* what assumptions would accurately describe a nuclear confrontation, or has a sufficiently sophisticated model of the atmosphere to predict with real confidence what the consequences would be. (Anyone who actually *read* TTAPS would know that the authors themselves pointed out some of the limitations.) I must recognize the possibility that something important has been omitted from the nuclear winter simulations, but I must also recognize the same possibility for any argument that purports to refute them. Even if I find one version much more convincing than the other, I don't expect to be able anytime soon to say with *certainty* that nuclear winter would or would not wipe out my species. And I am flatly unwilling to participate in the experiment. When the stakes are that high, "almost sure" is not sure enough to justify a course of action that shows even a little likelihood of producing such destructive results. If there is tenable evidence that

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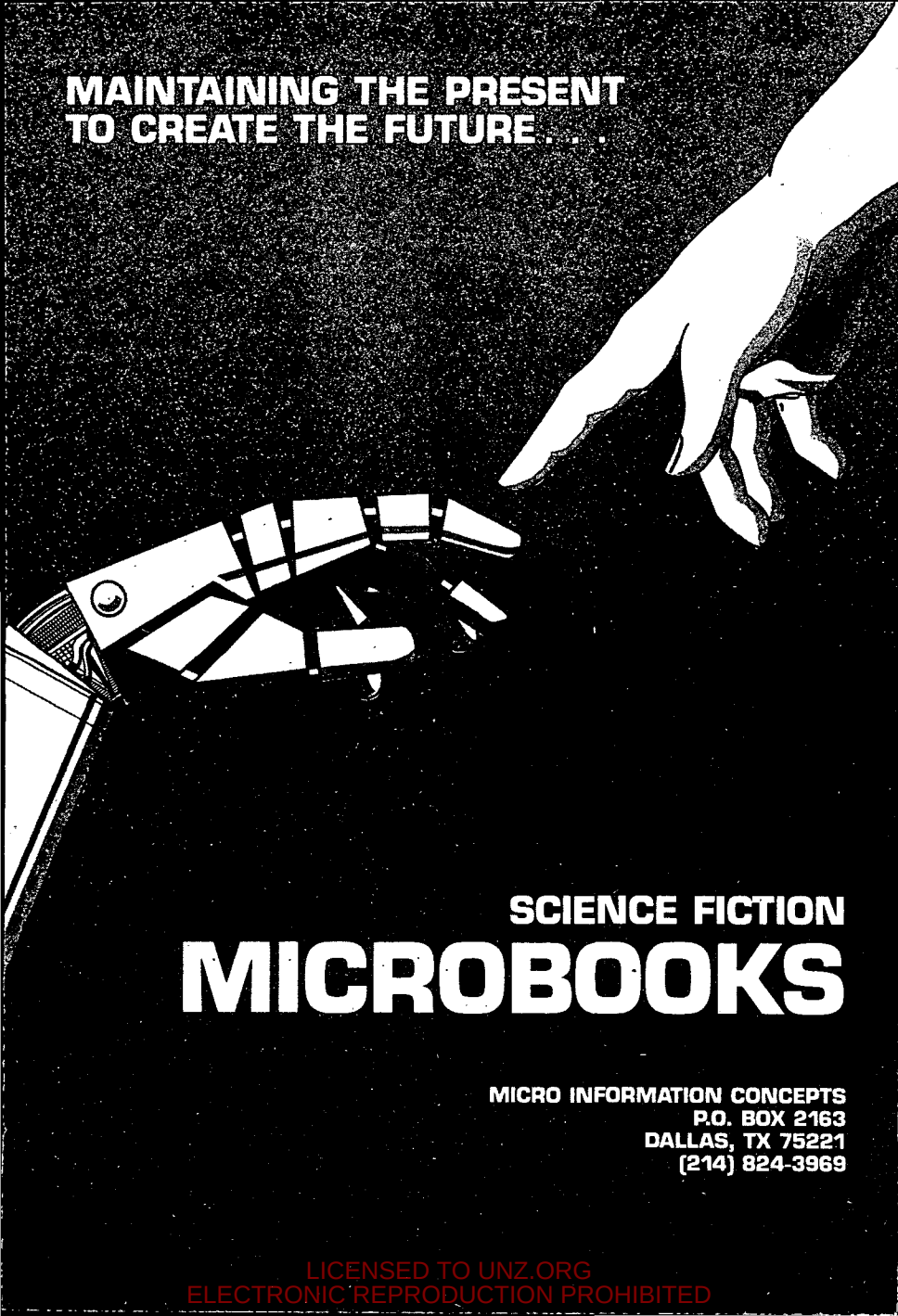

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it *may* have such results, that is plenty of reason not to do it.

I have occasionally heard scientific laymen speak disdainfully of how "cut and dried" science is. Such talk only proves that these people have never tried to *do* any science (or if they did, they didn't understand it). As hard as science has always *tried* to reduce things to clear-cut, absolutely reliable predictions, the real world has seldom cooperated enough to allow it to succeed. The effort is still worthwhile; studies such as TTAPS represent useful and important science, as do serious and well-informed efforts to poke holes in them. But the results remain statements of probability based on stated assumptions and interpretations, not certainty based on unchallengeable understanding of Reality. Any decisions made on the basis of them, need to be made with a full understanding of that fact.

The problem of "What do you do when there is doubt about the validity of your information?" is not new or limited to discussions of nuclear war. It has been present, to varying degrees, in virtually every decision ever made—because there is always *some* doubt. A host of examples can be found in medicine, where doctors and patients must make decisions about things like diet, exercise, and medication, which are expected to have some effect on the patient's health and longevity. Doctor and patient can usually agree that they want programs that will maximize chances of long life and good health while minimizing detrimental side effects. But human bodies are also very complicated systems and no two are exactly alike—so doctors seldom agree among themselves about which treatments have what effects, and the most popular views are constantly changing. At present, for example, many cardiologists strongly recommend regular and fairly massive doses of aerobic exercise. But at least one has recently published a book claiming that such programs do not produce the benefits claimed for them and may even be dangerous; and he has his supporters, too. What's a body to believe? Well, ya pays yer money and ya takes yer choice. One way or another, the patient himself has to decide which doctors and advice to follow, and act accordingly.

In that example, the most that is at stake is a few years' difference in an individual's lifespan; and the prevailing level of ignorance is such that it's hard to say with certainty, even after the fact, to what extent a particular regimen helped or harmed. Fortunately, none of the programs recommended is likely to be acutely and catastrophically dangerous. In that kind of case, doubt is always present and provides subject matter for those who enjoy worrying, but there isn't much to do about it and which advice a patient chooses to live by is not, in the long run, Earth-shakingly important.

But choices about nuclear weapons are. The nuclear winter theorists may have made mistakes, but it is not reasonable to shrug their work off as that of "wild-eyed fanatics." Unless someone proves far more conclusively than anyone has done so far that their con-

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clusions are very definitely off by many orders of magnitude, the chance is simply not worth taking. A thoroughgoing cynic might argue that for the long-range good of life on Earth it would be best if any species which can exterminate itself did so, but I'm not that thoroughgoing. I've been lucky enough to make the acquaintance of quite a few individuals who would not be among the perpetrators and who I think are worth keeping around. I see no reason why they should cheerfully submit to being obliterated by a few well-armed thugs among them. I would far rather see the dangerous elements eliminated from the species, whether that means getting rid of dangerous individuals or just dangerous attitudes and practices.

But when one of many possible courses of action holds the possible threat of species-wide and even larger destruction, while other courses don't, the one with the threat is not an acceptable option—even if there is a reasonable doubt about how real or severe the threat is. Therefore the nuclear winter theorists, as well as those who doubt them, should by all means continue to refine their predictions—but in the meantime, lots of people had better get on with the business of dismantling the unacceptable alternative, whether by construction of defensive screens, verifiable worldwide disarmament, or both. ■

● The relationship of language to thought is an old and hotly debated issue. At one pole are those who assert that thought and words are coextensive. . . . At the opposite pole are those who argue that we think without words, and that words are simply the labels we attach to our thoughts. One piece of evidence offered in support of this view concerns the words for colors in various languages. Anthropological studies have shown that in many other cultures, people do not have the same boundaries for color categories that English-speaking people do; some have fewer basic color terms than we, and one people, the Dani of New Guinea, have only two color terms—*mili* ("dark") and *mola* ("light").

Morton Hunt, *The Universe Within*

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I felt sure I was going to puke, but I couldn't let myself do it. Not with a Chip kid watching me, all ready to laugh.

She had come floating over to me upside-down, then did some sort of quick roll so that she was staring into my face. "Are you all right?"

What a question!

"Sure." I'd learned to tell that sort of lie by the time I was five years old.

"I know how you feel. Try to relax. First time up." She said it the way Chips often do, so that I couldn't tell if it was a question or a statement. With a tonal language like Chipponese, rules for pronunciation, like a rising final inflection indicating a question, go out of the window.

"We'll be docking in five minutes," she went on. At least she wasn't laughing at me. "There's nothing to be afraid of. I didn't go up myself until I was twenty-three."

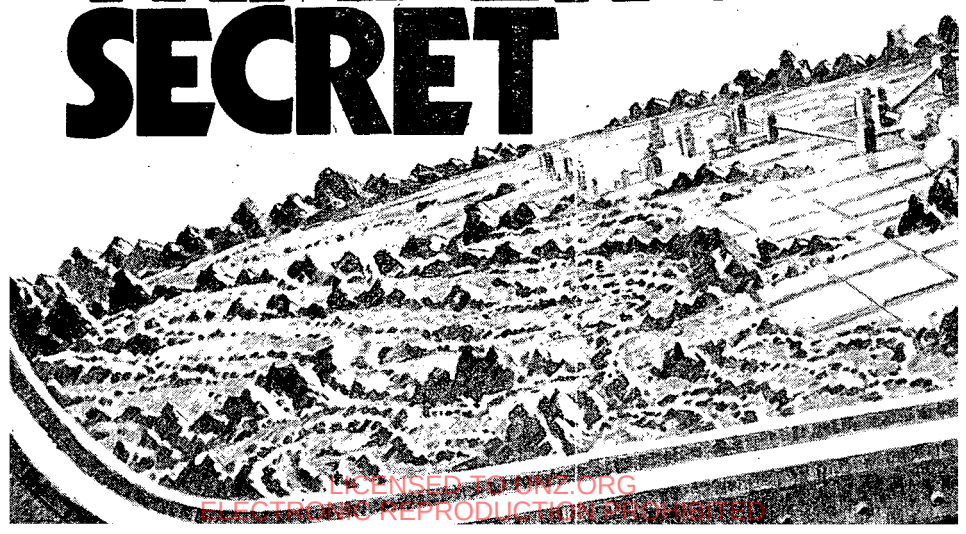
She looked about ten! Chip women don't have much in the way of boobs, and I'm damned if I can tell how old they are. For all I knew she could be my age.

"I'm not scared." I shook my head,

Loyalty and oaths are seldom as simple as they look—because any sentient being is a member of more than one group.

Charles Sheffield

TRADER'S SECRET



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H. R. Van Dongen

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which did terrible things to my balance centers and semi-circular canals. I swallowed, gripped the sides of my harness, and looked out of the port next to me.

I had been given a prime viewing position. As soon as I realized that I was seeing the world the wrong way up, I could pick out a few features. There were the Yankee lands, and even from this distance I could see the big difference between them and the Unified Empire (better known as Greaserland, when one Trader was talking to another). And there, spiralling into view . . .

"No!" The Chip woman grabbed hold of me and turned my head away. "Don't use Earth as your reference. We're spinning. You'll lose orientation, and then you'll—"

Too late. She held the bag in front of my face, while I said goodbye to the last meal I had eaten on Earth. For the first time, I wondered if I had been a bit too confident about this mission.

I had been well briefed, by Traders who had been up to the Geosynch Ring several times. The thing that I found hardest to believe was the warning that had come from Daddy-O: "Don't fall for a Chip woman! It's easy to do—more than that, it's built into you by Nature. It's Xenophilia, an urge to draw a mate from outside the tribe. Chip women don't look like much, but they're as far from you, racially, as you can get. So be careful. They'll grow on you."

Well, Daddy-O was usually right, and certainly there was no way a computer could be ascribing to me its own passions for Chip women. But so far the warning was entirely unnecessary. The Chip woman who'd held my head as we docked wasn't exactly ugly, but she had about as much shape and sex appeal as a grasshopper. And it seemed I was going to be stuck with her for the duration.

"My name is Li Xia, and I will be your companion for your stay on Synch-Seven," she said, once we were docked and on the first level of the geosynch station. She led me to a quarter-g facility to give my stomach a chance to put itself back together, then gave me a formal handshake. "I am very pleased to meet you."

I offered her a sort of grunt. Traders are strong on the formalities, but it seemed to me that I had already violated six sorts of etiquette by throwing up on her. "Hello," I said. "I'm Mike Asparian."

She was staring at me closely, as though she had never seen a Trader before. I felt entitled to return the compliment. I stared right back. Daddy-O's background briefings hadn't included pictures.

Li Xia was wearing a yellow sleeveless blouse and shorts. She was short and small-framed, as I had expected; but I was surprised by her fragile appearance and feeble-looking musculature. Her bones hardly looked as though they could support her weight, and the muscles attached to them were mere knobs of flesh. She looked as though she had escaped from a Lostland concentration camp.

Even so, she wasn't all that hideous. Her face was far too thin, but it had huge, dark eyes, a clear complexion, and an all-right mouth, and her light build gave her a sort of grace of movement in low-g.

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Meanwhile she was still looking me over from head to toe, and I saw her eyes linger disapprovingly on my mid-riff. I stood up straighter and pulled in my gut. Well, maybe I was carrying seven or eight kilos too much weight. I'd take it off during the trip. It wouldn't do to display more differences from the Chips than I had to—the secret to being a successful negotiator was to make each party think you were really one of them. With a Yankee I could pass myself off as a displaced farm-boy, and the Greasers seemed to think of me as a hot-shot gambling man. When I was with the Strines I approved fully of their white-only policy (no need to tell them about my one-quarter black ancestry); and as for the Chills, they thought I just loved to eat seal and penguin.

That covered all the bases. Nowhere else in the world was important to a Trader. The Chips were important, of course, but they weren't in the world any more, hadn't been for twenty years; so this was my first chance to learn their ways and practice them. And as a first move, I would get as skinny as I could stand.

While we were staring at each other a Chip male had come forward to stand beside Li Xia. He was waiting stiffly and self-consciously for my attention. I knew the Chip tradition. If I didn't look at him he would stand there for hours and never speak. He was round-shouldered and stooped, and he had a face like a frog.

I turned to him and gave him a smile that started and ended on my face, and didn't have any approval from my unhappy stomach.

"This is Ando Jia-Chi," said Li Xia. Her face was anxious. "He too is here from Luna. But he will be returning to the Moon and not staying here with us. I wanted you to meet him. Six months from now Ando and I will be married."

Everyone to his own taste, Missie Li, I said to myself as I shook his hand. And a right sight your wedding night will be. Like two stick insects rubbing themselves together and trying to light a fire. Rather you than I.

Were they *all* skinny, or were there

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fat Chips out here in space? I'd seen a couple in Greaserland, visitors from the area that had been to Japan before the merger and the Lostland war. But everyone I had seen so far on the shuttle and station looked ripe for the boneyard.

"Delighted to meet you, Mr. Ando," I said (Remember the Daddy-O rules: Chips put their last name first). "I think you have a delightful fiancée, and you have made an admirable choice for a bride."

Good diplomatic soft soap, the kind of thing I had learned over the years with the Southshore Yankees along the Gulf. Only this time I had somehow put my foot in it. Li Xia looked embarrassed, and Ando lifted his nose in the air at me as though I was a bad smell.

"Ando and I were chosen for each other by our families, Mr. Asparian," Li said. "Your congratulations should be given to them."

Oh, shit! "My apologies—to you and to them," I replied. "And my additional apologies to you, if I am the reason that you will be separated during my visit."

"No," said Li Xia. "That was my doing. I asked to be allowed to take part in the negotiation of the entertainment package. Ando is a specialist in energy systems, so his presence would not be appropriate."

I nodded, while Ando stood and stared at me, with all the charm of a plastic dummy.

Just as well he *wouldn't* be here, since the last thing I wanted hanging round me was an energy systems expert. It would be hard enough to get the information I needed for my mission if I was surrounded by innocents. With somebody who knew the energy business it would be impossible—they'd see the logic of my questions before I had time to sneeze.

I'm referring to my *second* mission, of course. The official one was Unified Empire business, the arrangement of an entertainment package visit for Chip top brass to Greaserland. (Trader's Rule: anyone who isn't working at least two agendas at once should give up being a Trader). The unofficial one was to look at the energy supply system on Geosynch Ring. The Yankees had finally mastered fusion methods, and they were tired of total dependence on Chipponese space power for their base load energy. They wanted to re-negotiate energy cost, but to do that they needed to know how much margin was in the Chip systems—quietly, which was where I came in. Energy systems were my special area, though never off-Earth.

Ando said something rapidly to Li Xia in Chipponese, and I quietly reached into my pocket and pressed a button. I had bought the miniature translator from a Chill merchant for a monstrous price, last time I was down on the ice-cap. It wasn't as good as the interpreters that hooked into Daddy-O—the computer offered fifty languages, with analysis as well as two-way translation—but my gadget massed only a hundred grams, including the earpiece. It was illegal to sell it to me down there, but that just meant I had to pay twice the normal price. It did everything the merchant had promised. (Someday we Traders had to find out how the Chills had managed such a big jump on the rest of the world in micro-electronics).

Li Xia turned to me. "Mr. Ando's apologies," she said. She spoke Trader,

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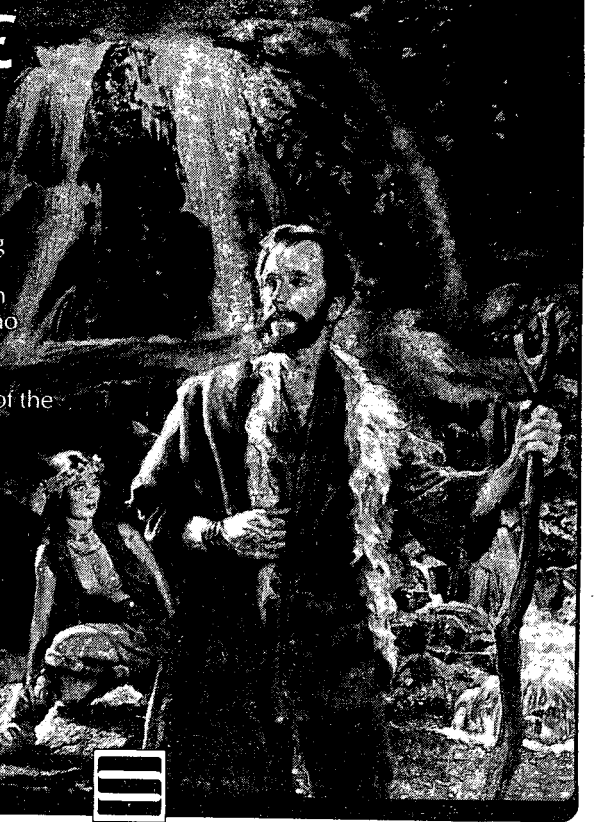

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so the translator didn't bother to give me a feed. "He is not fluent in your language. He asked me to invite you to be our guest at a meal, before he leaves again for Luna."

Trader's Rule: accept invitations to food, even when you don't feel like it. I bowed toward Ando, smiled, and nodded graciously.

Ando smiled back at me like a lizard and turned to Li Xia. Again there was a gabble of Chipponese.

"I gather that he accepted, and we are obliged to do it," said the translator in my ear. "I suppose that you feel it is necessary, if you are to succeed in your work. So we will feed him. Though he is already disgustingly fat and bloated, I am surprised there is more room for food inside him."

"He is corpulent," said Li Xia, again in Chipponese. "But that is not unusual for someone from Earth. By their standards he is not especially large. And be careful what you say—his dossier says he is ignorant of our language, but who knows?"

"I do," said Ando. "I have told you before, they are barbarians. Five thousand years ago, when we already had a flowering civilization, they were gibbering apes, swinging in the trees. And today their ignorance of other cultures still astonishes me."

That was a good test of my self-control. We Traders could trace our origins back over three thousand years—back to the Phoenicians!

"You will find that you can manipulate him easily," said Ando. "Let us get him drunk, and see what he knows."

While that went on we all three stood bowing and smiling at each other. I elevated Li Xia a notch in my esteem. She had some of the right material to be a Trader—say what you have to, and think what you want to.

With Ando leading the way we walked around the rim of the quarter-g chamber, to a place where food could be ordered. We sat at a table with hatches in the top, and Ando spoke again to Li.

"Ask him if he would like me to order food for all of us," he said. And this time he actually did say it, though I was careful to wait for Li's translation before I invited him to go ahead.

He called up the menu on the tabletop screen, studied it for a few seconds, then touched his finger to a series of items. My understanding of written Chipponese is primitive, only a little better than my hopeless spoken Chip. I could understand only that one course was soup. I was sure I could handle that, even with my protesting stomach. I was curious to see what we would be eating, because all the food came up from the Yankees, trading their agricultural products for the Chip's energy supply.

"It will be a few minutes before our dinner is cooked and served to us," said Li. "Perhaps while we wait you would like to take a look at Earth?"

I was going to decline politely, recalling what had happened the last time I looked at Earth. But it occurred to me that it was time I began to learn my way around this part of the Geosynch Ring, and I wouldn't do that sitting in the dining-room. I nodded, and Li Xia beamed at me.

"I have had no good opportunity to see this myself, since we arrived from Luna," she said. "And we both live on

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Farside, so a look at Earth is a rare occasion for us."

She led the way in toward the zero-g area of the central axis, then along that for about a hundred meters. My insides did one turn-around as we reached weightlessness, then decided that they had to make the best of a bad situation. With Ando guiding me from behind and Li tugging me from in front, I floated along like a jellyfish toward the viewing port.

Now that I was not on a small and rapidly spinning ship, the disorientation was tolerable. Earth was out ahead of us through the port, a thousand times the area of the full Moon. We were hovering over the equator, in the middle of the Indian Ocean.

"See there?" Li Xia pointed excitedly off to the right. "That is where my family lived, before the Heavenly Cloud came. My father was working on the Unification, and mother and I were with him."

The Chips have a talent for euphemism that surprises even me. I mean, I might give a moving mass of deadly radioactivity, thousands of kilometers across, many names. But *not* a Heavenly Cloud. The poison dust that had spread over China and parts of Japan during the holy war between India, Pakistan, Afghanistan, and Indonesia was anything but heavenly. It had wiped out three billion people—maybe more, because no one had been into the Lostlands of Asia to take a census. And the "Unification" that Li referred to was viewed differently in Trader eyes. The Chinese and Japanese had been busy murdering each other, with the Japanese losing, when they had both been faced with the greater danger of radioactive fallout.

Li was pointing at the place where she was born, an area of eastern China where a great river flowed to the sea. Even when we turned a telescope on it, we could see no signs of a city down there. But Li insisted that it had once been a great metropolis, with more than twenty million people living in it.

We scanned westward, across the dark uninhabited Lostland flats, and on into Africa. I halted the telescope to look more closely at the Atlantic seaboard.

"Did you ever visit that place?" said Li excitedly. "We are told that Traders go everywhere."

"Once," I said shortly. Our craft had touched down there, rumbling to a halt on a rutted earth runway, close to the equator with no sign of habitation in sight. We were exploring the possibility of a hydro-electric power station where the Zaire River flows to the sea—twenty-eight potential gigawatts of endless year-round power, all going to waste. Station construction would be easy, with no new technology, and it would lessen Yankee dependence on Chip power.

In less than a day I knew it was hopeless. That part of the continent was regressing, feeling its way back to the old balance with Nature. The population was down, the technology of the last generation had gone, the heat was murderous, and there was a stillness on the flat, smoking landscape. This part of Africa was turning its back on the twenty-first century, settling again into the ways of spear and slavery.

That experience was not something

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I wanted to talk about, even to the dispassionate ears of the Chips.

Li Xia seemed to read my mood. She nodded and turned to Ando. "Let us go back," she said in Chipponese. "He may be the barbarian you say, but this memory hurts him."

Seated again at our table, Ando pressed the dark area on the table edge as a command for the service to begin. I waited with fair interest—the visit to the viewing ports had somehow given me an appetite—as the first dishes came into view from the mid-table hatches.

Dinner was served.

It was revolting.

Cold octopus for appetizer, followed by sea-slugs stuffed with shredded pork. Snake soup—three kinds of snake, Ando told me proudly. And then the main courses, which seemed to be raw fish, fried eel, chicken parts (I got one bit with the beak still in it), and a black, slimy material which I didn't dare to ask about. The food was washed down with beer, interspersed with frequent toasts of *mao tai* liquor, strong enough to melt the wax out of your ears.

Trader's training: I sampled everything, and murmured my compliments as the endless succession of courses appeared on the table. And I drank every potion they ordered for us, and became gradually louder and more garrulous.

How I talked! I spoke of the Unified Empire, whose influence was gradually increasing on Earth as more and more resources went into addictive drugs, illegal sex, and pleasures that even now were not described in the brochures. I boasted of my trip to the forbidden interior of the Strine lands, where women used men as trading tokens, a human life was worth twenty gallons of pure water, and torture was one of the fine arts. I told of my journey under the ice cap, to the Pleasure Dome of the Chills, and how I had negotiated for the return of Seth Paramine, the Yankee *idiot savant* whose intuitive powers of circuit design had baffled the Chills and led to the secret kidnapping and unsuccessful brain probes.

In short, I behaved terribly. I talked too much, belched freely, knocked over my glass, and was insufferably rude to Ando. And since I had of course swallowed a de-tox pill before I took the first mouthful, I was cold stone sober and able to form an accurate impression of my hosts during dinner.

About the eleventh course (abalone and mushrooms, a merciful interlude) I was gratified to see that Ando's eyes were bulging, so that he looked more and more like a dyspeptic frog. He had been matching me, toast for toast, but I noticed he took a fraction of a glass each time. Even so, his body mass was probably only half of mine, and I had taken Trader precautions unavailable to the rest of humanity. Bye-bye, Ando.

Li Xia watched as her fiancé became less and less communicative, slumped lower in his seat, and let his mouth hang open. I was careful to notice nothing, and to chat on as usual.

By the thirteenth course she could stand it no longer. She stood up. "I am afraid that Mr. Ando cannot stay," she said. "His flight will be leaving shortly. If you will remain here, while we say goodbye to each other, I will return in just a few minutes."

Exit Missie Li, dragging old Frogface along behind her. I wasn't at all sorry,

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to see him go. Maybe that'd teach him a lesson. Barbarians! My ancestors were exploring the high seas while his were still crouching fearfully in the mud of China.

I poured myself another glass of the fiery liquor, and watched the tiny Chill-manufactured robot slaves scuttle out of the hatches, clean the food but leave the drinks, and disappear again. Somehow they could sense what foods and drinks were still being consumed at the table.

About twenty minutes passed before Li Xia reappeared. She slid into the seat opposite me, and I poured a tiny glass of sweet red wine and pushed it across to her. She had drunk almost nothing. She nodded, sipped, and looked at me seriously.

"Mr. Mike Asparian, I don't know how it is possible, but you are not intoxicated. Not in the least."

There was no accusation in her tone. I could have continued to act drunk, but somehow I didn't want to. Instead, I went on talking. But now I spoke the truth. Li Xia had looked wistfully at the great Chinese river, a childhood home that was now uninhabitable and denied to the Chip people. To make her feel better, I told her of the Trader life, how it felt to be part of a small, special group, with no land to call their own and every country seeing us as outsiders. And of our own pride in being Traders, the one group that all nations were willing to use as their negotiators. No one trusted any other's word—but everyone knew that a Trader's word held through torture and beyond death.

A Trader called no nation home. Our native habitat was on the seas and in the air. Traders were scattered all across the globe. Even Daddy-O, our central data repository, computer resource, and focus of all Trader activities, was a distributed system. Daddy-O's storage and computing units were everywhere, linked by microwave lines, fiber optic cables, and the Chip comsat links. And I was proud to be part of the system, humans and computers, the thin, indestructible web of Trader connections that permitted commerce to continue among the great power groups of Earth.

I had never mentioned those feelings before, not to anyone. I had scarcely thought them. But those great, sad eyes across the table from me drew out the words, and I said things sober that I would not normally have said drunk.

She listened quietly, those little hands cupping the silvery glass. When I finally ran out of words she put down her wine, reached across to take my left hand in both of hers, and turned it palm-upwards.

"Permit me," she said, and bent her dark head down to study the lines that criss-crossed my hand.

She was silent for a while, running her soft fingertips delicately across my palm. Then she shook her head.

"A wanderer's life," she said. "You will travel all your years, across strange seas and unknown lands. But I see humor and affection in your hand, and the chance of great happiness."

My hand was tingling under her touch, and at the same time I felt relaxed and comfortable. "Nothing more specific?" I said. "How long will I live, who will I marry, how many children will I have?"

She looked up at me, smiled, and shook her head. "That I cannot see. I

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wish that I could—for you and for me." The smile vanished from her face, as some other thought came to her. "I apologize for what happened this evening. Mr. Ando's behavior was not good, but he is not accustomed to drinking alcohol."

"He was merely tired. Please do not worry about it."

She had heard all of Ando's comments about me before he passed out. And maybe little Missie Li was smart enough to suspect that I could read his feelings from his face, even though she could have no idea that I was receiving a translation. Ando liked me no more than I liked him. "Ugly, stupid, and greedy," he had said. "A fat Trader swine . . . bloated imbecile . . . parasite on society . . . a slobbering, drunken glutton." Perhaps it was just as well that Ando had gone back to the Moon. Even with Li's moderating influence, our relationship had nowhere to go but down.

Li Xia was still holding my hand in hers. We both became aware of it at the same moment, and she released me and stood up quickly.

"Well." Her voice was breathless. "Mr. Mike Asparian, let me at least tell you how much I have enjoyed this dinner with you. The things you told me were enthralling. I feel as though we could sit and talk and laugh together for many more hours, and the time would fly past us."

I stood up too. "Perhaps we will have another chance in the future. Miss Li, you are a wonderful listener, and people tell you things. You would make an excellent Trader."

"Thank you." She smiled. "I know that you have paid me the highest possible compliment. But we must stop. There is a meeting with the senior members of delegation, twelve hours from now. Let me show you to your quarters. And you can rest."

Rest. An attractive thought, but not yet.

Sensitive to my unfamiliarity with freefall, the Chips had assigned me a sleeping area on the outermost lower ring of Synch-Seven. The whole assembly had a double-wheel design with a single central axis. The lower wheel was reserved for living, communications, and recreation quarters. It rotated about the fixed spindle that jutted down to it from the upper wheel. With a diameter of four hundred meters, Synch-Seven's lower part had an effective gravity that ran from near-zero at the hub to about a quarter-g at the outer rim. I was on the rim, while Li Xia had a room a third of the way in that came close to Lunar gravity.

The upper section—the part I was more interested in—did not rotate about the spindle. The whole upper wheel had negligible gravity, and no residents. All the power generation, contruction, and maintenance resided on that thick upper wheel. It was not off-limits to me, but all the same I took a while getting there after Li had said goodnight to me and headed for her own sleeping quarters.

The only way to reach the upper wheel was by traveling in from the rim to the center, then upward along the central spindle, then back out again toward the periphery. It sounds easy, and the thing that slowed me down was infuriatingly trivial: I didn't know where the light switches were located in the

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spindle. It was impossible to fumble my way along the spindle in freefall, when I had no idea which way I was going, or even if I was tumbling end-over-end.

Once I was in the upper wheel things became a lot easier. There were lights, and a few people in the corridors, dressed in technician's uniforms. As an obvious non-Chip, I received the expected number of polite inquiring looks, but no one tried to speak to me or stop me.

I got roughly as far as I expected. At a branch point in the corridors, big signs in red announced: "NO ADMITTANCE to these areas without badge and permit. DANGER. High radioactivity sector."

A good way to keep people out. I suspected that the signs were there for just that purpose, because they were written in Yankee, Greaser, Strine, Chill, and Trader, as well as Chip. But radioactivity wasn't something I was willing to mess with. I turned round and quietly went back toward my quarters.

On the way I passed a couple of familiar faces, individuals who had been in the corridors earlier. It made sense. The Chips were double-covering me. Li Xia was Team One; and the second team would remain unobtrusively present, as a good back-up team should.

I went back into my quarters, lay down on the bunk, and closed my eyes. Then I sub-vocalized my report, the full description of events since I left the surface of Earth for the flight up to Geosynch Ring. That went onto my Trader Recording Sphere (TRS). When I returned to Earth—or if I didn't, but the Sphere did—the record would be transferred to Daddy-O's files for analysis. I guess that I could stand perhaps twenty g for a short time, and a temperature maybe a couple of hundred degrees above freezing. A TRS would survive accelerations of ten thousand g, and temperatures of two thousand degrees Celsius. I had been told that it would survive orbital re-entry, without shielding, but that was a claim unsupported by experience—and I didn't want my Sphere to be the first test case.

I didn't know if the Chips had sensing equipment on me that would pick up my sub-vocal report. And I didn't care. Trader rule: assume that if you say it, it's recorded. It's still safe to think it and not be overheard, but maybe tomorrow that won't be true.

Recording over. I'd had enough for one day. I switched off the Sphere, lay back with my eyes closed, and was asleep within minutes.

On second thought, maybe Li Xia was Team Two. Certainly the group who met with me for negotiation were no pushovers. There were four of them, in addition to Li. And each one of them spoke perfect Trader, had a totally unreadable face, and wore an almost-invisible earpiece that told me they were being prompted by the Chip central computer.

Even without all that I would have been wary. The Chip toughness in negotiation is legendary.

But so is the Trader's. I was as keyed up as I have ever been, and pretty confident (but I wished I had Daddy-O to whisper in my ear). We sat down, five on one, around an aluminum-topped table. As part of the natural attempt to keep me off-balance mentally, the Chips

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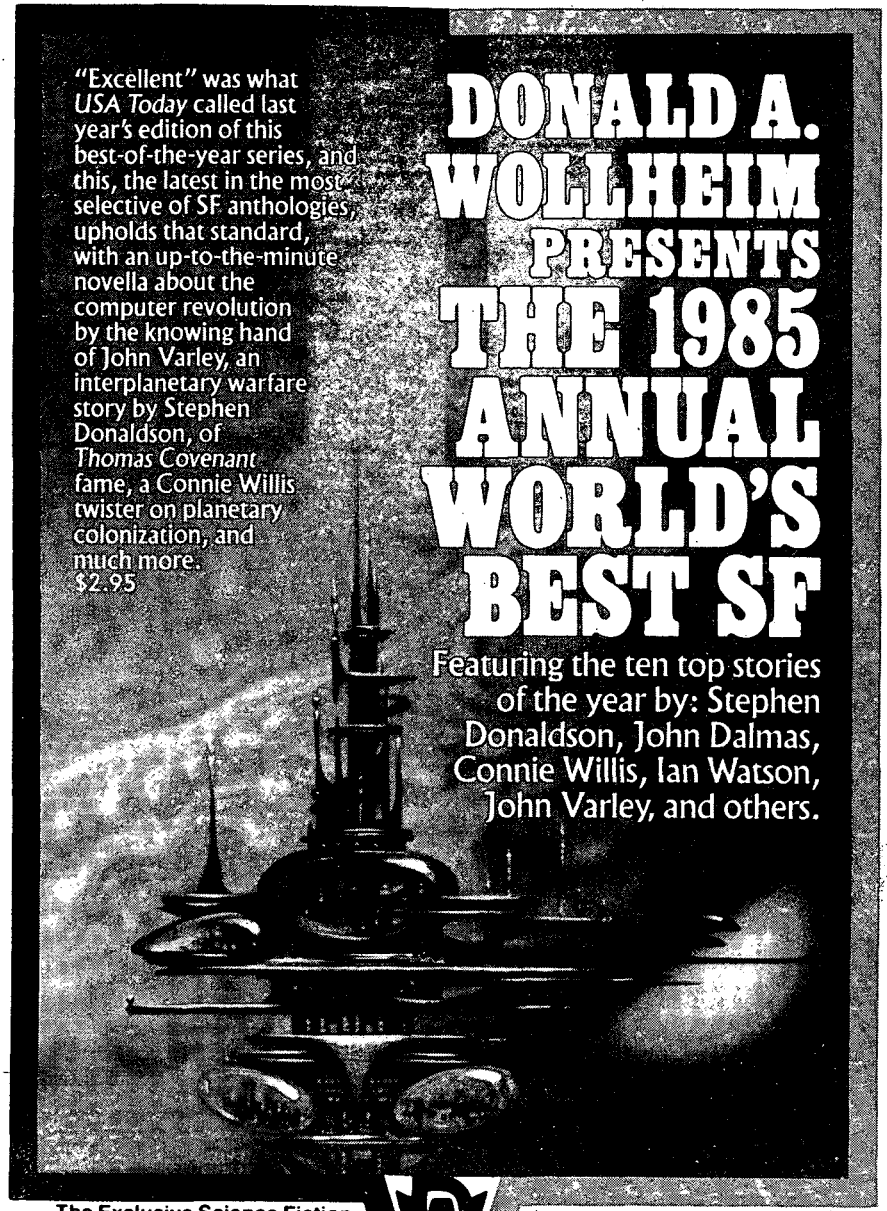
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had placed us in a low-g conference room. The traditional hot tea and sugar lumps were served—but the tea was drunk from a squeeze-bulb, and the sugar lumps tended to float away from you when you weren't looking.

Li Xia opened the discussions, while the others looked on. "We are prepared to pay three gigawatt-hours," she said. "To be delivered over a two-year period, at any selected point or points of the Unified Empire grid, or anywhere else in that hemisphere. We offer a two-to-one daytime/nighttime ratio, and a forty percent power increase during Southern Hemisphere winter. In return, we want a two-year access contract for one hundred people, entry point Guyana, free movement within the Unified Empire."

While she was still talking I was already busy with my calculations. Her offer sounded simple, but it had implications. First of all, the Chip tastes in vices were well-known. Their visitors to Greaserland would only be looking for recreational drugs and gambling, not for sex, sadism, cannibalism, or any of the other really expensive services. And chances were that the Chips would actually leave behind a good part of the money they brought in. They were good gamblers, but the Greasers were the best. (We *would* be the best, but Traders don't gamble—not in that way.)

Second, everyone at the table knew that the energy offered in contract to the Unified Empire would not be used there. Most of it would be traded with the Yankees, whose agricultural programs called for huge energies in irrigation and fertilizer production. And some would be traded to the Chills, high-level energy users, in return for electronic equipment. To evaluate the Chip offer, I had to estimate the balance of trade levels between Yankees, Chills, and Greasers, for the next two years. And I had to add one variable that was in theory unknown to the Chips: the Yankee fusion program, and their new ability to achieve self-sufficiency in energy.

"Counter-offer," I said. "The Chipponese presence in the Unified Empire will be as Li Xia stated. But the delivery will be for three and a half gigawatt-hours, with a three-to-one day/night ratio, and no Southern Hemisphere winter increase."

I was admitting by my last statement that I expected most of the power to be delivered to the Yankees, in the Northern Hemisphere. But why not? —the Chips knew that already. (Trader rule: Tell them what they know—it gives them a false feeling of confidence.)

The Chips leaned forward across the table, and went at it with their own calculations. While they did so, I had time for a look at Li Xia, and a feeling of something close to pity for her. Not only was she betrothed to old Frogface, but she and all the Chips were going to lose their prime market for power, the Yankees. The Chips relied upon them for nine-tenths of their food supplies. What would happen when the Yankees had ample power of their own, and didn't need them?

Well, that wasn't my worry. And if history was any guide, the Chips would get by. Their native lands had become uninhabitable because of the Lostland war, but they had survived—even though they had to leave Earth to do it.

"Counter offer," said the man op-

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posite me. His name was Wang Tanaka, and he was unusually heavy-set and full-faced for a Chip. I suspected that he was of Japanese ancestry.

"Three and a quarter gigawatt-hours," he continued. "But an access contract for one hundred and twenty Chipponese citizens for a period of two years. Restricted transfer of energy delivery, with not more than thirty percent going to the Northern Hemisphere of Earth. . . ."

We were off and running. That restriction on delivery showed more clearly than anything that the Chips knew the real game as well as I did. And underneath *that* real game was my other agenda. Somehow, sometime, I had to visit the Geosynch Ring energy facilities and do my evaluation of them.

After seven hours we were still arguing, but we were converging. At that point Wang Tanaka called for a two-hour recess, to "let our visitor take a break" —which is to say, to let them put their heads together and decide the next move. Li Xia's relatively junior role was confirmed when I was told that she was at my disposal, to show me anything that I wanted to see on Geosynch Ring.

It was an offer too good to refuse. Before any other alternative could be proposed I was leaving, with Li trailing along behind. After a ten-minute scratch meal of hot noodles, fried pork dumplings, and tea, we were heading for the upper wheel.

"Good progress on the negotiations," she said, as we moved into the central spindle.

"Excellent," I replied. "We are already close to agreement."

She turned to face me—a freefall maneuver I had not yet mastered—and gave me a little smile. "You say we are near agreement—but I don't think you believe that statement." (A definite indiscretion on her part. I don't think she was supposed to be so honest with me about the status of the talks.)

"It depends what you define as 'near agreement,' " I said. "I believe that we are exactly where I expected us to be at this time. We have several days of negotiation ahead of us, but we have made good progress."

And I sure as hell wasn't supposed to say *that* to her. Mainly because it was true. Before we were finished we would have half a dozen cases of 'near agreement,' then one party would introduce a new complication that seemed to kill the deal. We'd inch forward, then backward. But we'd get there eventually, after several more days of work—and I might need all that time to accomplish my other business on the Ring.

I thought some more about that exchange of comments as Li led the way through the spindle into the upper wheel. What was going on between the two of us? We were talking to each other much too freely, just as though we were old friends and on the same side of the argument. Until I understood why we were doing it I'd better learn to hold my tongue.

As we moved away from the upper wheel axis I missed a handhold and began to turn end-over-end. Li reached out effortlessly to correct my attitude, and to do it she pivoted her hip and shoulder across my chest.

God, she was thin! Skin and bone. But somehow, with all the other Chips around, I had stopped noticing it most

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of the time. If anything, I felt oversized and fat.

At my request, we were making a general tour of the upper wheel. The overall wheel layout had been known to the Traders for a long time, and Daddy-O had provided me with detailed plans to learn before I left Earth. Now it was mainly a question of making sure we saw the right sections, the ones where the energy generation equipment was housed.

I had no illusions about what I would and wouldn't see. The Chip energy production facilities were scattered all around the Geosynch Ring, a mixture of nuclear and solar power plants. Here on Synch-Seven there would be only nuclear, and only medium-sized reactors. And we were on the wrong side of the world for the facilities that served the Yankees and the Greasers. I could get no more than a rough snapshot of the overall energy supply situation, but the Yankees presumably had other investigations going on in parallel, and my observations would add to those. The Strines were in the deal too, and during my stay at Synch-Seven they would briefly double their power demand, allowing me (with luck) to see how the supply system responded.

Following Li Xia out toward the perimeter of the upper wheel, I had an uneasy feeling that we were playing with fire. Remove the Yankee energy demand from the global picture, and what would happen? The Chips depended on that energy sale to let them buy Yankee ag products—so the Chip economy might collapse. And that would have effects everywhere on Earth, including effects on the Yankees and the Traders. But what effects?

It made me think back thirty-five years, to the last big set of changes. It had started then with the internal collapse of the Soviet Union. They had overstretched their economy for the joint needs of space and defense. A single event, but when the SU fell apart, three things had happened: they had given up their space program; they had lost control of their European and southern satellite states; and they had become preoccupied with internal problems. The chain reaction had spread to three other areas: without the stimulus of defense and competition, the old United States had dropped out of space, too; the Lostland war had started in the southern USSR, and spread across the whole of south Asia; and the Chipponese, faced with obliteration as a result of Lostland fallout, and barred from the spread southeast by the impregnable Strine defense system with its haploid abo killing teams, had moved in the only direction remaining to them. They had used the superb Japanese launch facilities on Kyushu, and taken over space.

Conclusion: today's world was the direct consequence of the economic collapse of one power group! And the collapse of the Chip economy might produce changes just as great.

My train of thought was interrupted by our arrival at the wheel section that contained the power systems. And suddenly I had a whole new set of parameters to worry about.

The power units looked wrong—totally wrong. Wrong because they were *familiar*.

The Trader information on Chip power

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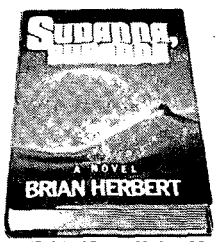

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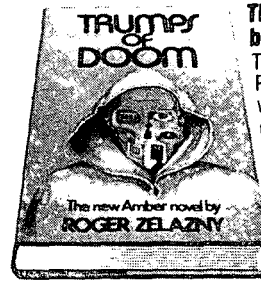

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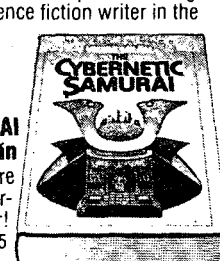

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systems had been painstakingly collected over the years using a combination of public data and private espionage. But the Chips were very careful with their technology, and the last big design leak had been nearly a decade ago.

Now I was looking at those same designs—which said there had been no progress on Geosynch Ring energy production in ten years. And that was simply unbelievable. Even back on Earth, without the Chip focus on energy systems, there had been a steady advance in nuclear reactors.

I looked more closely. The units were not merely old designs—they were old equipment. The fuel recycling machines showed the scars and pitting of long use, and the pressure vessel seams showed evidence of many repair welds. The Chips were generating energy for transmission to Earth on antiquated, beat-up production facilities.

While Li led us on farther, higher in the wheel, I struggled furiously to make sense of the evidence.

One obvious possible conclusion: this was a set-up. The Chips knew of my undercover mission, and they had arranged for my negotiation to take place on a station that carried only old equipment. Then they could show it to me and give nothing away regarding their real production capability.

I dropped that idea as soon as we reached the uppermost part of the wheel. This area held a second set of power units, much smaller ones that served only to generate and beam power to the Chip communication satellites that were scattered all the way around the Ring. And these units were new, compact, and far more advanced than any designs that I had ever seen.

On the way back down to the lower wheel I had the chance of another look at other power generation equipment farther down the wheel. It merely confirmed my perplexity. The machinery was old, appeared poorly maintained, and was running near to its limits.

That led to another worrying thought, and one I could not ignore. The sudden doubling of Strine power demand would be coming in a day or two, without any warning given to the Chips. That was all part of the Yankee plan for system tests. The system should have an automatic cutout when the power called for was too high—but the monitoring and control equipment looked fully as old as the power generation equipment itself. I didn't trust it, and the chance that something would blow was unacceptably high. But what should I do? If I alerted the Chips to a possible danger, it would reveal that I had more on my mind than negotiation of the entertainment package. And I would be giving very poor service on my Yankee contract. But if I *didn't* warn the Chips, and something went past the danger point . . .

I puzzled the problem all the way back to the lower wheel, then right on through the following four hours of negotiation. Training and experience allowed me to haggle with my five Chip negotiators at almost a subconscious level, while my forebrain remained preoccupied with the mystery of the out-of-date Chip power systems. But it was a strain. When we finished for the day I was a wreck, ready for no more than dinner and relaxation.

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Li acted as though she was as weary as I was. She yawned her way to the dining-area, where she ordered dinner for both of us. We slumped opposite each other at the smooth-topped table, too tired to do anything except wait quietly for food to appear from the hatches. The menu was less exotic tonight, with only beer and tea served as our drinks.

By unspoken agreement this was Li's turn to talk. I learned of her early childhood in Shanghai, and the shock to her infant life when mother and baby daughter had followed her father to Japan, as part of the Unification conquering forces. The Lostland war erupted while the Unification was still incomplete.

Time had been desperately short. Before the poisoned belt of the Heavenly Cloud reached eastern China and Japan there was perhaps three months warning—three months to decide which parts of the countries were inevitably lost, and abandon them; three months to define a six-times-a-day Shuttle launch program that would assure a continued Chip existence (provided that the space environment was friendly); and then many years to mourn lost friends and relatives, and to grieve over the fertile acres of the Yangtze river valley that would now never welcome the return of Li Xia and her family.

The food and drink slowly restored our energy and spirits. By the time the final course appeared we were talking of more personal matters. Li asked me if a Trader always had to marry a Trader.

I shook my head. "There's no absolute requirement. For example, I could ask a Yankee woman, or a Chill woman, or any other non-Trader to marry me. Then I would formally ask our Council to accept *her* as a Trader, too. But if they didn't agree—and that has happened, a number of times—I could no longer be a Trader and go through with the marriage. I'd have to apply to be a Greaser, or a Yankee, or whatever."

"You are not married now?" she asked. She had been looking down, running her finger around the top of her glass and collecting the droplets of condensation there, but now she raised her head and stared straight into my eyes.

I felt a little shiver up my spine. Li's eyes were so dark and serious, they seemed to see right through me.

"No." I said. "Not yet. But someday I hope to be. To be married, and have a family of my own. I never knew my own mother and father. They were killed during the pacification of the States. I would love to have a little daughter."

And again I felt surprise. I was saying words to Li Xia that I had never before spoken to anyone. She nodded.

"And I would give anything to have a baby son," she said. Then she smiled at me. "Wishful thinking, maybe. But it is good for us to have dreams." She reached over and squeezed my hand. "I hope that one day you will have your daughter, and I, my son. But now, we must not become sad over the future. Come—you are not eating your dessert."

She was right. Li had ordered a chilled white confection, almond-flavored, that was served in a broad, shallow bowl of frosted glass. I looked at mine, then picked it up and looked again. I was not sure how I was supposed to eat it—there was no spoon.

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She noticed my confusion. "Like this," she said.

She raised the bowl close to her mouth, extended a long, slim, pink tongue down into the glass, and licked at the frozen white dessert. Her big, dark eyes watched me over the rim of the cup. The operation looked perfectly easy and perfectly natural, like a graceful butterfly delicately drawing nectar from a white blosson.

I tried to imitate her action. My tongue didn't seem long enough. While she watched I pushed my face farther into the bowl, and came away with almond dessert on my nose, eyebrows, chin and forehead—anywhere except in my mouth.

Li looked at me. First she giggled. Then she began to hoot, and after a couple of seconds she collapsed. She leaned forward until her forehead was resting on the smooth table top, and shook with helpless laughter. I sat motionless for a few seconds. Then I reached forward and put my hand gently on her mop of dark hair.

And I decided, in a moment of black thought that came from nowhere, that I hated Ando Jia-Chi and the Chip system of parentally assigned marriage.

The next day it was more negotiation, business as usual—almost. But by the time that we began I had a couple more worries to add to my list.

The first came at the very end of the evening, when I was all ready to stand up and say goodnight. Li had placed her hand on my lips and said these two words: "Traders' Oath."

I stopped in my tracks. "Do you know the significance of what you are saying?"

She nodded calmly. "I know very well. I am acting for my government. We would like you to work for us, and if you accept Trader Oath I will give you information that cannot be revealed to anyone."

"To anyone, with the exception of the locked Trader data bank," I said.

"My apologies, I was imprecise. The information would go to no other *human*." She smiled. "We know all about Daddy-O."

I thought for a moment. I had my hands full now, but whatever the Chips wanted me to do, it wouldn't be up here on the Geosynch Ring. It would be a job back on Earth.

I nodded. "I accept. What you say to me tonight will be under Trader Oath."

I didn't talk price—not yet. That would depend on the nature of the task, and would have its own negotiation.

Li motioned me to sit down again.

"You have had extensive dealings with the Yankees," she said. "Are you familiar with their agricultural production system, and the way that their economy depends on the supply of energy from us?"

My brain did a couple of cartwheels, while I did my best to keep all expression off my face. Did the Chips know my mission, that I was here to set up a basis for Yankee negotiation for energy?

"Li Xia," I said. "You appear to have some misunderstanding of Trader Oath. It means I will *accept* confidential information—not that I will give it."

She smiled serenely. "I know. Let

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me begin again. It is of great importance to us to know the degree of dependence of the Yankee economy on the continuous supply of energy from us. And we want to know how other groups on Earth would be affected should the Yankee economy run into difficulties. We cannot determine that information for ourselves. We believe that you could find out, once you return to Earth. We would like to employ you to do so."

Given the battered, beat-up condition of the energy generation equipment that I had seen earlier in the day, her comments had an ominous tone. My own feeling was that the whole Earth economy would fall apart if the Yankee system went belly-up because of loss of energy. Today the balance of the industrial groups was workable, but delicate—it could not survive a major upheaval in any of the Big Five powers. A year or two from now, when the Yankee fusion system came on-line, it would be a different story. But not yet.

I nodded. "I agree. Subject to a negotiation, I will attempt to do what you ask."

Li didn't know it, but in this case I was bound by the most basic of Trader rules, the one that each of us learned last and usually found hardest to obey. Here is every Trader's Prime Rule: You are a human being first, and a Trader second.

"Can you tell me more?" I said. "Do you anticipate problems in providing an energy supply to the Yankees?"

She shook her head. "I am not permitted to answer that question. Good night, Mike Asparian. May you sleep like a child and have pleasant dreams."

Fat chance. I'm sure she meant it, but I spent a good deal of the sleep period attempting my own assessment of the whole situation. And at breakfast my second new problem reared its head. For a few long seconds, all the lights on Synch-Seven went out.

They were back on before my heart could skip more than a couple of beats. And when I asked Wang Tanaka about it before our negotiation began, he was quite casual and relaxed.

"It was just the lighting that went off," he said. "All the more critical station systems and the power delivery service to Earth have their own standby power. There was no danger. What you noticed was the removal of one station reactor for regular maintenance. It will be out of service for a couple of days. But don't worry, the rest have more than enough capacity."

He sounded unperturbed and reassuring enough, but as he spoke I saw Li's face. It was drawn and unhappy, the eye sockets like black holes into her skull. She had wished me pleasant dreams, but her own had not been peaceful. She had slept worse than I had. Something was eating her; and the Geosynch Ring energy supply had to be involved.

We began the second day of negotiation. We made steady progress, but I noted one oddity. In every deal there are certain items which are simply non-negotiable—the other party will give away everything else to preserve them. And of course it is a Trader's job to deduce those non-negotiables, and exploit them.

The Chip blind spot was this: no matter what the offer and the inducement from me, they would not consider an energy delivery deal that lasted more

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than two and a half years. Thirty months out I met a wall, an absolute barrier for their position. I could offer them anything, but if it also implied a contract of three years or more there would be instant rejection.

The negotiation ground steadily on, but by evening I was operating largely on instinct again. Two facts were increasingly dominating my thoughts: a power reactor was out of commission in an already ramshackle production facility; and the increased energy demand from the Strines could come at any moment.

I had to take another look at the generation system, and make my assessment of the danger level. It might ruin the negotiation, but the Prime Rule gave me no choice. A Chip reactor blow-up could be a nuisance on Earth, but here on Synch-Seven it would be a disaster.

At the first opportunity I headed for the upper wheel. Li followed me closely, but asked no questions, not even when I made a close inspection of the reactors and power transmission systems—not part of my official role on the Geosynch Ring, nor an area where the Chips knew I had expertise.

It was worse than I thought. The equipment was hanging on by a thread, with radiation levels too high, sticky control rods, and worn mechanical linkages. And there were far too few maintenance personnel.

Li had silently watched my every action. When I finally stopped, looked around me, and shook my head, she took me by the hand.

"Come," she said. And she led us upward, past the reactors that produced power for Earth, past the new and well-maintained equipment that provided power for the communication satellite network, and on to the extreme tip of Synch-Seven, where its central hub extended outward for half a kilometer beyond the wheel. We drifted up along that long, straight corridor, to its very end. There the spindle terminated in a spherical chamber about twenty meters across, with transparent panels on all sides. Solar shields cut off the sunlight, leaving us with a view of the Moon, half-full against a glittering star field.

We floated together, side-by-side and silent, for endless minutes. I was waiting, and finally Li spoke.

"Mike Asparian, I believe you are a good man. This is not said under Trader Oath, but I hope I can trust you."

"You can trust me, Li. Trader Oath is not needed."

"Thank you. I am going to tell you what I think you already suspect." She turned us to face each other. "If my fiancé, Ando Jia-Chi, knew I was saying this to you, or if my family knew, they would disown me. I beg your silence."

"Li, you will never need to beg me for anything. You *command* my silence." I did my best to smile at her. "But I am sorry that Ando cannot know."

"Ah." She looked quickly away from me. "I understand. Do not say that—not now. I need all my strength to say what I must say. Listen closely."

She moved again to look at the Moon. "Today, up on the Moon, there is a great argument among my people about Earth. One group says that Earth is part of the past, and its present welfare means nothing to the Chipponese people—who cares if Greasers starve, or

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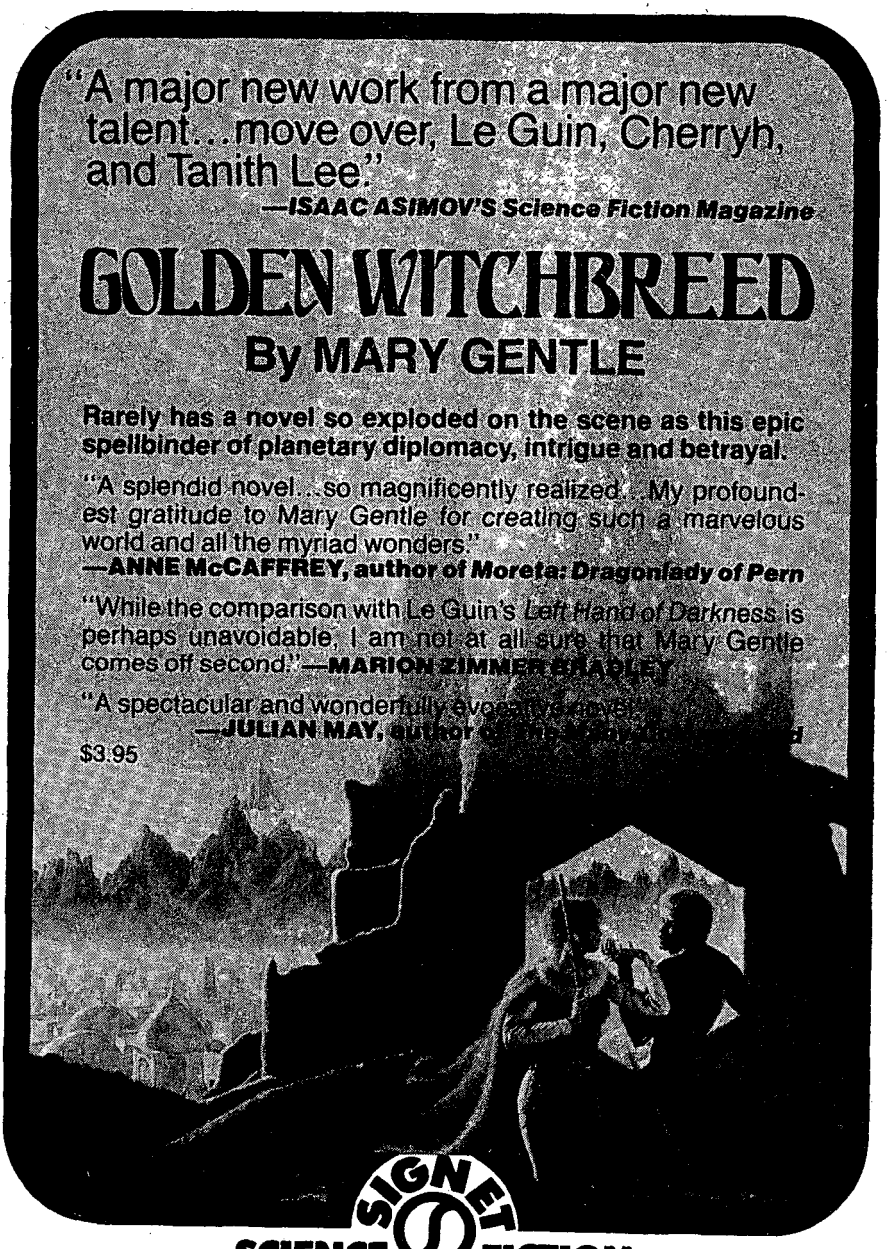

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Chills freeze to death, or the Yankee coalition collapses? Another group—a smaller one—cannot accept such an attitude. We are all humans, and the unnecessary death of any human, anywhere, diminishes us. I am part of that group."

She paused for long moments. I was impatient, but I knew that I must let Li take her time. She could not hurry. She was feeling her way into this, looking for the strength to say something that her family, fiancé, friends, and people had all forbidden her to say.

"The Chipponese space-systems supply energy for the whole world," she went on at last. "That has been so for a generation now, and there is a stability that everyone cherishes. But what would happen if it broke down? You have seen the condition of some of the equipment. What if Yankee food products could no longer be traded for our energy, or if the Chills would no longer provide their micro-electronics to all the other groups?"

I took a deep breath and cursed mightily to myself. At this point I should be telling Li of the Yankee move for energy independence, but I was bound to silence by Trader Oath. All I could do was nod my head.

"It would be chaos," she continued. "Political chaos, then perhaps war, starvation, sickness. But there are people who do not care about this. In the name of their particular group interests, they are willing to destroy stability. Unless everyone knows of their plans now—"

She broke off. Along the spindle of the station an eerie wailing noise had begun, resonating through all the structures. Li turned her head to look back along the corridor.

"Energy demand overload," she said. Her voice contained no great concern. "That noise means the shields will be going up as an extra safety measure. We ought to go back at once."

I had to make a decision, but in reality it made itself. Trader Prime Rule.

"Li," I said. "You can call down to the main wheel from here, can't you? Do it, and tell them to be ready for a doubling of usual Strine demand—it has already started. Then we can head back."

Bless her, Li didn't take even a moment to ask or argue. While she was passing on the message, I had time for my own thoughts. Goodbye, one client. I couldn't invoke Trader Prime Rule with the Yankees, that was not something we ever talked about outside Trader groups. And as far as they were concerned, the hell with the people on Synch-Seven. I was ruining their test—when they had sent me up here to help them with it!

Li took longer than expected to get her message through. Without my translator switched on I could not follow her quick gabble of Chipponese, but I could tell that she was having a credibility problem and had to say the same thing several times to different people. Finally she put the communications unit back on its base.

"Quickly now," she said.

With Li leading we skimmed back down the long tunnel toward the main wheel. But when we were less than halfway there Li caught a handhold and waited for me to reach her. She pointed at the tunnel wall, turned, and began to drag me back the way we had come.

After one look at the ambient radia-

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tion level I needed no persuasion. Something in the energy production facility was not doing its job, and the tunnel was a hot spot.

"What now?" I said, as we came once more into the end chamber.

"Let me find out." Li took the communicator again, while I looked around the chamber. There were no additional radiation shields here that could be placed in position, and no other way back to the main wheels. If the failure below was a bad one we were well situated to sit and fry.

Li again replaced the communicator. "Not too bad," she said. "Partial failure of one reactor. The engineers used manual overrides and have cut power back to minimal supply levels. There will be no need to evacuate the wheels, but all personnel will move to the base of the lower wheel for maximum shielding."

Good news—for everyone but us.

"Very fine," I said. "But how do we get to the lower wheel? The tunnel is hot, there are no more shields, and the monitor over on the wall says there's increasing hard gamma flux in here."

"We leave," said Li calmly. "As soon as we can."

She went over to a wall cupboard, opened it, and pulled out two suits.

"You mean we take a space walk?" It was not something I was sure I could face, no matter what the incentive.

"No. We take the lifeboat." She was looking critically at the suit. "There may be a problem. These suits were made for someone smaller than you. You must remove your clothing first."

No time for argument. She watched me strip to the skin, then looked again at the suit she was holding. "Come on. It will be a tight fit, but I will help you. It will be uncomfortable, but you will be in it for only a few minutes."

Between us we managed to stuff me in and zip me up. I felt ready to burst out at the midriff, and I swore that if we got out of this alive I would lose ten kilos immediately. Li slid easily into her suit, motioned me to follow, and moved to a door in the tunnel close to the end chamber. It was not until we were through it that I realized we were in an airlock.

She hadn't lied to me—not in her definition. We didn't need to take a space walk. But we did have to make a space hop, one of about fifteen meters between the station and the lifeboat entry lock. That hop is something I would rather not think about. It felt to me like a couple of lightyears. As soon as we were inside and Li had checked the atmosphere she opened her suit and went across to the ship's communicator.

This time the conversation was mainly from their end. About halfway through Li quickly began to strip off her suit and motioned to me to do the same.

She took off her clothes, too—something she didn't need to tell me to do. I had left all mine back in the chamber; not to mention my translator and my Trader Recording Sphere. I felt naked in more ways than one.

Li took clothes and suits and dumped them out into space. A bad sign. Then she ran a radiation monitor over both our bodies. "Hot," she said to me. Then there was another, longer conversation over the communicator. It ended abruptly when Li put the instrument

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down, apparently in the middle of comments from the station.

"We will live," she said. "But we need decontamination treatment that is not available on the Geosynch Ring."

"So how do we get it?"

"We go to the decontamination center." She looked at me speculatively. "On the Moon."

"On the *Moon*," I objected. But then I stopped. The Chips on Luna were the experts on nuclear energy production, and as an unpleasant consequence they also knew the most about treatment for radiation overdoses.

"Can we get there in this?" I said. I had a sudden vision of a three or four day naked ride through space, and a naked landing on Luna. And I had a suspicion that the thought had already gone through Li's mind.

"Of course we can get there. I have already asked for a minimum-time trajectory."

"How long will it take?"

"About two days travel time."

"Naked?"

"Naked." She was moving toward a cabinet built into the rear part of the ship's main cabin. "Don't worry, we will not be aware of it—I have been advised to sedate us until our arrival at the treatment center. The ship's lunar approach and landing are all under automatic control."

I had to hope the spacecraft control system was a lot better than the one on the station's power production. Otherwise these would be our last moments of consciousness in this universe. Li was already pulling out a phial of liquid and loading the spray injector and timer of the medical unit. We moved over to twin bunks near the control console, and I held out my arm.

"What else did they say?" I asked. "You seemed to cut them off."

"I did." She smiled sadly. "It was nothing of importance for the moment. They wanted to know what you and I were doing, out in the chamber at the end of the station. I chose not to tell them. And I do not propose to obey their other instructions."

"What—" I began. Then the spray injection took effect. My last waking moment saw Li Xia, still smiling wistfully, while the injector moved to her thin, fragile forearm.

I awoke slowly, with nausea, a sore throat, and aching joints. Li was floating above me, still naked, unconscious, and held to her bunk by the padded restrainers. After a few more drowsy minutes, I summoned the energy to loosen my own strap supports and look around me.

Where were we? Not on the Moon, that was for sure. We were still in free-fall.

I went across to the medical facility and put my hand into the wrist collar. The unit buzzed and whined, but that was all it did; apparently there was nothing wrong with me—or nothing that it could fix. Major radiation decontamination was beyond the scope of a ship med unit.

On the other bunk Li was opening her eyes. I released her from the straps, floated her gently over to the med unit, and let it make the same diagnosis for her. No injections. I would have given Li a good dose of carbohydrates, fats, and proteins, but the unit disagreed. For

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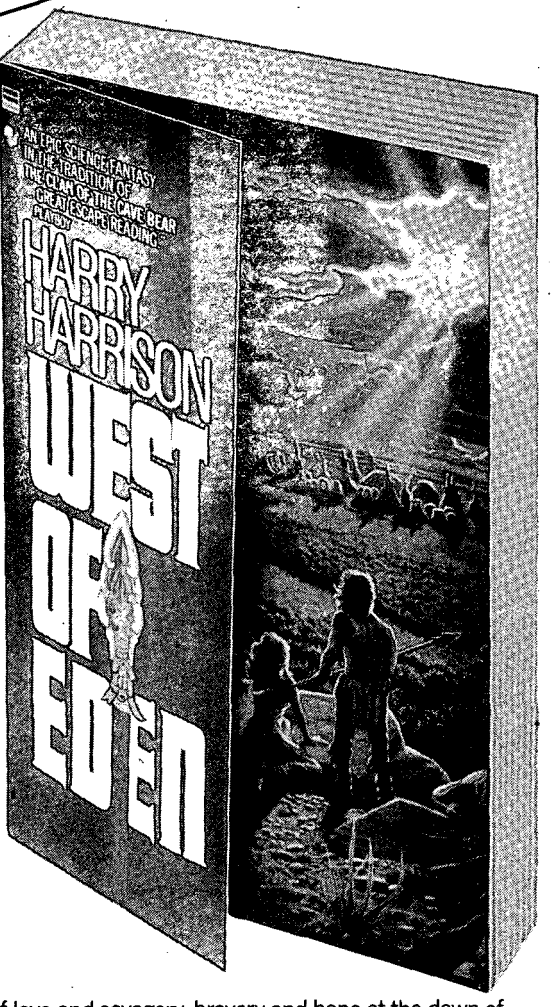
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a Luna-dwelling Chip she was apparently not frail or undernourished.

I took a look out of the side viewing port. Nothing but open space.

Li was wide awake now and watching me.

"Not the Moon," I said to her.

"No." Her voice was husky—like me she must be feeling the first effects of radiation poisoning.

"I guess we've got more problems." I tried to sound cheerful.

She shook her head and cleared her throat. "Not the sort you mean. We will make our lunar landing in about one hour."

"I thought we were supposed to wake up in the lunar treatment center."

"Those were my instructions." Her voice was tense. "Specific instructions—with my father's and grandmother's authority added to the station message. You were to be unconscious until we were inside the center. As I told you, I am disobeying my orders."

From her tone I guessed the price of that disobedience.

"Why?" I said.

"So that you can see something that has been kept a secret. Our accident on Synch-Seven gives us a unique opportunity. There is something that you *must* see. After that—" she shook her head slowly "—whatever they do to me, there can be no going back."

She seated herself at the console, and adjusted the attitude gyros so that the spacecraft turned slowly in space.

"Back on the station I asked you a question," she went on. "What would happen if the Yankees and Chips stopped trading food for energy? You saw the condition of the energy generation equipment on Synch-Seven, but maybe you thought that we have no more than a temporary problem. That is not the case. Look out of the side port."

Coming slowly into view through the port was the broad face of the Moon. We were approaching it, and soon we were so close that I felt we were skimming the surface and must collide with it. I know now that was an illusion.

Maybe we were thirty kilometers above the surface, but certainly we were close enough that I could see every detail of that gray, pock-marked wilderness. I looked for signs of the Chip settlements. They were mostly underground, but here and there I saw linear patterns of trails leading out from some central point—mines, or drill holes to tap into trapped bodies of ancient ice and ammonia.

It was something that I had seen a dozen times before in pictures released by the Chips. It was no more appealing now than it had been then. I marvelled at the patience and persistence of the Chips, driven away from their radioactive home on Earth, forced to rebuild their society burrowing in the wilderness of Luna, or out in open space.

We were orbiting the Moon now, swinging around toward Farside, to the hemisphere never seen from Earth. But there was no change in the terrain—just more endless dreary wastes of dust and rock. I turned back to Li.

"What do you want me to look at?"

"Keep looking. *Just keep looking.*" Her voice was full of tension. I moved back to the port.

The first hint of it was a change in the color of the light. Instead of the usual cold, gray-white spectrum of the

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lunar surface reflection, there was a growing hint of a brighter, richer tone.

And then it came.

Suddenly we were looking down on a vast, geometric pattern. Endless kilometers of Farside lunar plain carried a regular, rectangular grid. And within each grid cell, beneath the soft blue-gray sheen of a continuous plastic canopy, I saw the bright green of growing plants.

Fields. We swept on over the surface, mile after mile after mile, and the pattern continued.

"First harvest in four months," said Li. Her voice was dreamy. "A generation's work. Twenty years, to prepare the surface, to modify the plant genetics, to drill for water, to add the protective canopy. And in four months we will see the first full harvest."

I was stunned. The fields went on forever. "But the labor and the resources! How could you ever do it?"

She nodded. "Of course, that was a problem. When we went from two billion people to fifteen million, there could be no army of workers, bent over every plant. Our fields are tended by machines, with Chill robot circuits in them. No one regrets the change."

I was still reeling mentally. "Li, the amount of work, the sheer size of this. Why do it? The Yankees can supply you with all the food you need."

She smiled. "Ah, they can indeed, but you do not understand us. We think of this differently. It is more than food, it is our whole existence. My people have lived close to the land for seven thousand years. We have worked it, and loved it, and drawn our strength from the growing crops. How could we change, just because we were driven away from Earth? How could we abandon the land? This has used all our resources for a generation—the best minds, the best equipment. Everything connected with Earth carried second priority. And now we are almost finished. In three more years we will be in full production. Self sufficient at last."

And then, at those final words, the life drained from her face. For a few minutes, her pride had overwhelmed everything. But not for long. Now her worries were coming back.

"Self sufficient," she repeated. "And now, some of us must ask the question: what will happen to Earth? Are we destroying Earth, to make a garden of the Moon? That must not happen. That is why I called on you for Trader's Oath, to tell us what will happen when the Yankees learn that we have our own food—and they have nothing to offer us in exchange for energy."

"But Li," I said. And then I paused. I did not know what to say. I had the words to comfort her, the news that the Yankees were close to the point of their own energy sufficiency, that Earth's economy would not collapse. But the information had been given to me under Trader's Oath.

We sat in a terrible silence for several more minutes, while the Moon's face skimmed past us. Soon the ship's attitude must be changed to prepare for landing at the decontamination center. We had to act.

Li had been holding the control console, rocking herself backward and forward. I took her arms and turned her to face me, still not knowing what to say. If only she had been a Trader, too . . .

Her eyes had a full, liquid look,

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something I had never seen before, a pair of dark, crystal globes with internal reflections. After a few moments I realized what had happened. Li was crying; but in freefall the tears had remained on her eyes instead of trickling down her cheeks.

"Worse yet," she said. "I have done a terrible thing. I have disobeyed my own family's direct command, and I have betrayed my people. And worst of all, I am placing you in an impossible situation. When we land my people will ask you under Trader's Oath not to speak of what you have just seen. But I am begging you to pass the word, secretly, to the governments of Earth. And if you do that, you will break Trader's Oath and lose your own family."

I sat dry-eyed. The monstrous tableau below me, those endless miles of cultivated fields and neat channels, still took my breath away. But there were no tears in me, only resolution and a curious inner peace.

I was not in an impossible situation. I would obey the Trader Prime Rule, and be a human first. For the first time I understood what that implied. Everything else in the Trader Rule Book offered advice, counsel, or warning, and drew Traders more closely together. The Prime Rule was different; it alone gave no comfort, demanded individual responsibility, and offered freedom of choice.

"Do not cry," I said quietly to Li; and I spoke those few words in poorly-pronounced Chipponese.

"I did a terrible thing. You will lose your family," she said again.

"No, I will not."

Then I did a terrible thing, too. I broke Trader Oath. I told her—a non-Trader, a stranger to Trader customs—of the Yankees' fusion project, and the progress of their energy programs. I did it, and I did not even ask for her silence.

And then I hugged her to me, and I said many other things to her, in words that were old under the Sun and new above the Moon, words that belong to Li alone and have no place in any record or on a Trader Recording Sphere. And I dried her tears, and finally coaxed a smile, and felt like a new-crowned king.

Li is right, but she is also wrong. Maybe when I get back I will tell the Traders down on Earth everything; maybe not. But I can never lose my family.

I know my family now, for the first time. When the world was young we rowed our galleys far to the West, past the Pillars of Hercules, to trade for tin in Ultima Thule; our caravans plied the Great Silk Road, braving deserts, bandits, and disease to carry goods from Cathay and Samarkand to Venice and Damascus; we lived and died for our work, trading for spices in the East Indies, tea in Serendip, ivory in the Congo, gold in Alaska and in the high Andes. Our spiritual grandfathers sat and haggled in every sun-soaked, rug-filled store from Rio to Manila, while our fathers wriggled on knees and elbows around the muddied, blood-filled shell craters of Verdun and the Somme, crossing No-Man's-Land to swap cigarettes and candy for cheap coffee and tins of bully-beef.

I know my family. Take away the Trader name, call us what you will. We—Li, and I, and our children's children's children—we will survive and flourish, as long as the human species endures.

And we will always be traders. ■

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Stephen L. Gillett, Ph.D.

THE OZONE ROCKET

Is this another bit of "neglected research" worth reviving?

Herewith I make a prediction: Chemical rockets will be our space transportation system into LEO (Low Earth Orbit) until well into the next century. Even after that, they will remain important for special applications. Systems such as skystalks to geosynchronous orbit, skyhooks, or orbital rails will be built, and probably built sooner than we really expect. But those systems are beyond current technology, and they will be extraordinarily expensive. They are also "capital-intensive," in business jargon: the expenses are all up front, so that a return on the investment will begin only *after* the system is built completely. They will not be built until investment in space is routine.

For now, a vehicle such as a rocket is less expensive and requires (comparatively!) less expensive support facilities. Compare a railroad, with its tremendous capital and maintenance costs, not to mention the costs and delays of right-of-way acquisition, with a semi-tractor trailer rig. True, the truck cannot offer the economies of scale, but it is much cheaper. The truck is also lots more flexible: It takes a vast volume of business to justify building a railroad spur, but much less to scrape out a track for a truck. (The logging "roads" here in the Pacific Northwest are a good example.)

Well, since we're going to be using chemical rockets for some time to come, we should look into making them as efficient as possible. What makes a rocket efficient? The most useful parameter to characterize rocket performance

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is "specific impulse":

I_{sp} = (thrust)/(propellant flow).

Specific impulse has a simple interpretation: How much thrust do you get for the mass of propellant expended? For maximum performance, you want the most thrust for every gram that gets thrown out the tail.

Specific impulse has the dimensions of thrust (= force) divided by flow, where flow is mass per unit time. Thus the units look like:

force / [(mass/time)].

With a little algebra, this rearranges to:

(force / mass) × time.

In the English system of units, both mass and force are commonly reckoned in pounds[1], whereas time, of course, is in seconds. Hence American rocket engineers traditionally cancel pounds *force* with pounds *mass* to express specific impulse in *seconds*. Similarly, metric engineers have often canceled kilograms force and kilograms mass to get exactly the same "seconds" parameter. (And these people have even less excuse; the metric system makes a much more careful and consistent distinction between force and mass.)

I'll express specific impulse in "seconds" in this article, too. It's a sloppy usage, but we're stuck with it. At least it gives conveniently sized numbers. For any further calculations, however, you must be sure to convert "seconds" into the proper units.

What does this mean for chemical rockets? In a chemical rocket, energetic chemical reactions yield hot gases which are ejected through a nozzle where their expansion produces thrust. Hence, in a chemical rocket the reaction mass thrown out the tail also stores the energy to do the throwing.

Therefore, to maximize specific impulse in a chemical rocket, we need two things. First, we need chemical reactions that yield a great deal of energy. Second, we need exhaust products of light molecular weight, because those produce the most thrust per unit mass of fuel. Given a choice between two chemical reactions that produce the same amount of energy, we would pick the one that uses the lighter atoms. We can carry more of them along.

Of course, specific impulse isn't everything. All else being equal a denser fuel is better, because the same mass fits in a smaller space and minimizes the tank size. Chemical stability is important: High-energy propellants that detonate in the tank are not particularly useful for rocket propulsion. Cost of the propellant is also an obvious consideration. And finally, the rocket exhaust must be as non-polluting as possible. This last point is particularly important for large rockets that operate high in the atmosphere, and I'll return to it later.

The rocket pioneers realized that combustion fits several of these constraints. Burning a fuel, such as gasoline or alcohol, with an oxidizer, such as liquid oxygen or nitric acid, releases a great deal of energy, more energy than

[1] A "pound" is 0.453592 kg, but it is also the force exerted by a one-pound mass at the Earth's surface; that is, a *mass* of one pound *weighs* one pound when subjected to a gravitational field of one g.

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comes from an explosive like gunpowder or nitroglycerine.

Nitroglycerine, for example, releases about 6 kilojoules per gram, the maximum depending on the exact composition of the decomposition products. Even the combination of nitric acid and hydrazine, an Old Reliable that's hardly the state of the art in rocket propellants, does as well as that. By contrast, an ethanol-oxygen mixture, still not the last word propellant-wise, yields over 8.5 kilojoules per gram.

Combustion is also safer than explosives. Separately, the fuel and oxidizer are relatively stable (although precautions must be taken to prevent their reacting with the storage tank); they burn only when they're mixed. And if the fuel and oxidizer are liquids, the rocket is easy to control, because you can meter the flow of the propellants to the combustion chamber.

These advantages are bought at a slight increase in complexity, because you need *two* separate storage and pumping systems: one for fuel, and one for oxidizer. Still, the system has proven very practical. All the largest rockets use liquid-fueled systems on this basic pattern.

What is the most efficient combination of fuel and oxidizer for a liquid-fueled rocket? The liquid hydrogen/liquid oxygen combination used in the most advanced rocket engines, such as the Space Shuttle main engines or the Centaur upper stage, comes pretty close to optimum. Oxygen is cheap. Hydrogen is relatively cheap, although it is not quite as cheap as hydrocarbon fuels like kerosene. Finally, the reaction of hydrogen and oxygen yields high energy (about 13 kilojoules/gram) and a low molecular weight product—water. That means high specific impulse (Table 1).

Hydrogen does present some technical problems. It is not as dense as might be wished, which leads to awkwardly large fuel tanks. It's also *extremely* cold, boiling at 20°K; only liquid helium is colder. But, in another of the unsung advances of space technology, liquid hydrogen by the ton can now be handled safely and routinely. This, well, *routineness* would astound the engineers of the 1940s and early 1950s (are you spinoff-loggers taking notes?)

Not only is the hydrogen-oxygen combination high-energy and affordable, it is pretty nearly non-polluting. The exhaust product is just superheated steam—and water vapor is a normal, indeed ubiquitous component of Earth's atmosphere. We need not worry about the environmental consequences of dumping tons of water vapor into the air.

Well, OK, not completely. Because the rocket exhaust is so hot, a small fraction of the water molecules are split up into highly reactive fragments such as OH, and these may react with atmospheric gases. But such unstable molecules occur naturally in the upper atmosphere anyway, where they are formed by the breakdown of atmospheric water vapor by high energy solar ultraviolet.

A brief note about Table 1: Specific impulse is not a constant for a given fuel and oxidizer. Like a liquid's boiling

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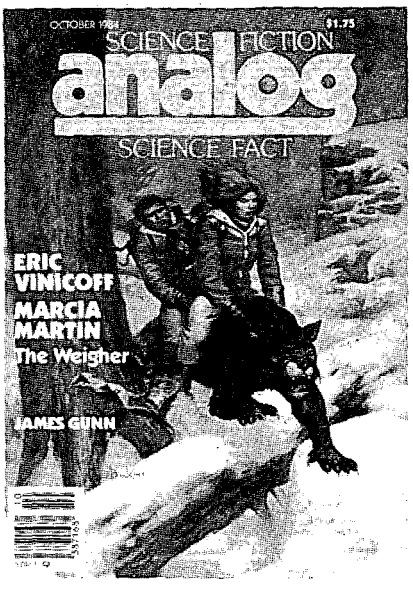

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point, it varies with conditions, depending on the details of both the combustion chamber and the combustion itself. To "compare apples with apples," therefore, the data in Table 1 use the same combustion chamber parameters and the same model for the combustion, that of "shifting flow." In shifting flow, you assume that the exhaust gases continue to react in the nozzle after they've left the combustion chamber. This model yields higher specific impulse, because unstable molecules in the combustion chamber react

Table 1. High Energy Rocket Fuel-Oxidizer Pairs

			Fuel/Oxidizer Ratio			
Fuel	Oxidizer	Product	As Atom Ratio	As Molecular Ratio	As Weight Ratio	Specific Impulse (Seconds)
H_2	O_2	H_2O	4	4	0.25	391
H_2	F_2	HF	9	9	0.47	410
H_2	O_3	H_2O	6.75	4.5	0.28	424

All calculations assume "shifting flow," a combustion chamber pressure of 1000 psi, and an exhaust pressure of 14.7 psi. Source of data: *Energetics of Propellant Chemistry*, by B. Siegel and L. Schieler, Wiley, 1964.

The three columns under "Fuel/Oxidizer Ratio" express this ratio in three different ways, first as an atom ratio, second as the molecular ratio, and last as the weight ratio (or mass ratio, technically). Which form is most convenient depends on the problem you're looking at.

Note that the optimum fuel/oxidizer ratio occurs with a substantial excess of hydrogen. At first glance this seem strange, because the maximum energy is obtained when there is no excess of either fuel or oxidizer. Why is the maximum performance not obtained at the maximum energy output?

This paradox arises because the fuel/oxidizer combination in a chemical rocket serves both as energy source *and* as reaction mass. Thus there's a tradeoff between maximizing energy production and minimizing the average molecular weight of the exhaust (the *two* fundamentals determining I_{sp} in a chemical rocket, remember?). The maximum I_{sp} occurs when some free hydrogen is present in the exhaust to lower the average molecular weight.

in the nozzle and release additional energy. Fortunately, shifting flow is a good assumption for hydrogen-oxygen combustion—it's nice to have something work out in our favor!

Fuel-oxidizer combinations with somewhat higher energy yield than hydrogen-oxygen are possible, but none has ever been used other than experimentally. For example, you can spike

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liquid hydrogen with the light metals lithium or beryllium, which yield more energy than H_2 upon burning with oxygen. Liquid fluorine, either straight or in combination with liquid oxygen, has also been investigated Fluorine is a better oxidizer than oxygen, so burning hydrogen with fluorine to yield HF (hydrogen fluoride) yields a higher specific impulse than burning hydrogen with oxygen (Table 1).

These exotic fuel/oxidizer combinations have technical difficulties that could be solved. However, they also suffer from two fundamental defects; they are neither cheap nor environmentally sound.

Hydrogen and oxygen are common, not just in the crust of the Earth but in the Solar System as a whole. Beryllium, lithium, and fluorine are rare, and therefore expensive.

Beryllium and its compounds are also highly toxic. Although lithium is nontoxic, both it and beryllium burn to solid combustion products, which form aerosols. Aerosols high in the stratosphere probably have major environmental consequences. Volcanic ash, for example, a natural aerosol that occasionally gets injected high into the atmosphere —as in the eruption of El Chichón—may cause climatic cooling. Everybody by now has also heard of the "nuclear winter" scenario, which is the hypothetical cooling that would follow the injection of aerosols by a large-scale nuclear exchange.

Finally, hydrogen fluoride is not only highly toxic but ferociously corrosive. In one early test, the experimenters took elaborate precautions to contain the HF exhaust in a fully enclosed housing that was flushed with water. Later, the HF was precipitated from the water solution with lime. (With their environmental concern, this group was ahead of their time in the free and easy '50s.)

Besides being corrosive and toxic, hydrogen fluoride high in the atmosphere would catalyze destruction of the ozone layer, which shields the Earth's surface from deadly high-energy solar ultraviolet. The conquest of space is worth profound sacrifices, but it is not worth the destruction of the terrestrial biosphere.

So is hydrogen-oxygen the ultimate combination for a chemical shuttle rocket? Well, perhaps not. Let's think about ozone.

Ozone, O_3, is a toxic, reactive form of oxygen, most familiar in the stratospheric ozone layer I mentioned above. As a highly reactive form of oxygen, ozone enthusiastically supports combustion, releasing considerably more energy than O_2. For example, you get almost 16 kilojoules per gram by burning hydrogen with ozone rather than oxygen, a gain of about 20%.

In a chemical rocket, a back-of-the-envelope calculation suggests that this gain would lead to a 9.5% improvement in specific impulse. Things aren't actually that good (they never are); more detailed calculations yield a smaller but still significant improvement of about 8.4% (Table 1).

Not much, you say? Not so. (Tell your accountant that expenses are going to rise 8%, and watch his/her reaction!)

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But more to the point: rocket improvements are now an evolutionary process, just as airplane improvements were two generations ago. A few percent here, a few there, and yet a few more over yonder, and suddenly the second or third generation craft is much more efficient and much more economic than its predecessor. You can't afford to tinker with such details when you're trying to make the machine work in the first place—but the fine-tuning must come later.

Liquid ozone is also denser than liquid O_2, which leads to savings in structural mass. You can build smaller tanks. In addition, although ozone is toxic, it poses no long-term hazards. If accidentally vented to the atmosphere, it will be consumed by oxidation or revert to ordinary O_2 before too long. The economics are also good: ozone is easy to make from oxygen by passing O_2 through an electric discharge at low temperature; no major chemical contortions are required. And oxygen, as I've said, is cheap. Finally, the clincher: The combustion product of O_3 -H_2 is just plain, old, non-polluting water.

Awright, what's the catch? Ozone is not used in rockets; it is not even being researched. (Although, admittedly, rocket fuel research is sort of passé these days. Some work with ozone was done in the '50s and early '60s.) This inattention is an unfortunate by-product of ozone's high energy. The ozone molecule is unstable with respect to ordinary O_2 and decomposes with the release of heat:

$2\ O_3 = 3\ O_2 + 34$ kilocalories per mole O_3, or about 3 kilojoules/gram.

Boom!

There's no free lunch; ozone's extra energy doesn't just appear but is stored in the molecule. Further, decomposition like ozone's is particularly tricky because it is self-accelerating. The energy released by one molecule's decomposing jars neighboring molecules into decomposing also. In turn, the energy of their decomposition triggers yet more molecules . . . and you end up with a spectacular explosion.

Some molecules that can decompose spontaneously, because they release energy by doing so, are nonetheless easy to handle because they require a substantial nudge to begin decomposing. It's like a ball bearing on a ledge. If the ledge is flat, the smallest push will send the bearing off the ledge. On the other hand, if there is a lip on the edge, the nudge must first be forceful enough to raise the ball bearing over the lip.

Alas, as you've already guessed, ozone needs a modest nudge indeed. Not only is ozone sensitive to heat, it is extremely sensitive to shock—mechanical impact. Such behavior is highly antisocial in a rocket propellant, which at the least will slosh in its tank, and which must also undergo being pumped and valved on its way to the combustion chamber. After a few shattering explosions in rocket test cells, it's no wonder the rocket researchers of the '50s and '60s gave up on ozone in disgust.

Well, is ozone hopeless? Possibly so . . . but we don't know; the in-depth research has not been done. Perhaps there are handling techniques, or sta-

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bilizing additives, that will allow ozone to be used routinely and safely. Lots of commodities are handled routinely nowadays that were nightmares a generation ago. (Remember liquid hydrogen itself!)

In this article, I've used a straightforward hydrogen-oxygen rocket for discussing ozone. There are also several exotic proposals for high performance chemical rockets. In one such, fuels and combustion chamber parameters are varied so as to optimize performance. In another, a hypersonic ramjet or "scramjet," air would be scooped in for oxidizer during the passage through the atmosphere. Ozone research is even relevant to these schemes, because both require some on-board oxidizer.

Finally, assuming a way is found to tame ozone, let's speculate on the ground-support facilities for the "ozohydrogen" shuttle. As I mentioned, ozone can be made by passing gaseous oxygen through an electrical discharge, the conversion becoming quite efficient at low temperatures. Such "ozonizers" will probably be built at the spaceport, oxygen being turned into ozone and the ozone liquefied when the rocket is fueled. This would obviate having to transport ozone long distances. In fact, you could power an electrical rocket fuel plant with a solar power satellite; first, water is electrolyzed into H_2 and O_2, and then the oxygen is fed to an ozonizer.

This plant will produce a substantial surplus of oxygen, because the highest performance ratio in a chemical rocket is not at the exact ratio H_2O. In fact, the optimum fuel/oxidizer ratio for either oxygen or ozone contains about twice as much hydrogen as the water molecule requires (Table 1).

Ozone is a high-energy oxidizer that can be made cheaply and that yields non-polluting exhaust. Its taming is worth further research. ■

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● I have never heard of anything, and I cannot conceive of anything more ridiculous, more absurd, and more affrontive to all sober judgement than the cry that we are (profiting) by the acquisition of New Mexico and California. I hold that they are not worth a dollar!

Daniel Webster, U. S. Senate
March 23, 1848

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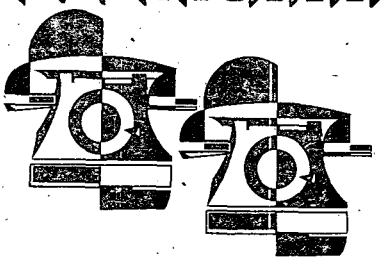

Probability Zero

MASS COMMUNICATION

Jay Kay Klein

Dear Phone Companies:

This letter is being mimeographed so each of you listed in the cover sheets will receive a copy. This is going to everyone who bills me each month since I'm not sure exactly whom to contact. I would have done this by phone instead of by mail, but as you may already realize, this would be very hard to do.

Perhaps I should start at the beginning. I live in a semi-rural area, just an unincorporated township with about as many cows as people. Until a few years ago, my local calling area covered just these 2500 people. I paid $8 a month plus a few dollars extra in a month whenever I had to use long distance. I really didn't use the phone very much, but it was nice to know in an emergency I could reach the volunteer fire department or sheriff's station. An occasional wrong number even provided some excitement.

Then the phone company (there was only one then) introduced its Extended Calling Area which covered the whole county. This meant I could reach every person in the whole county without paying extra for long distance or dialing a series of complicated numbers. Rates went up to $25 a month, but I was assured that this was a bargain, since I could now reach 500,000 people on a local call. This was a good cost/value

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ratio the phone company said. I did notice that I was now getting an average of three wrong numbers a day.

I think it was three years ago that more cost effectiveness was handed to me, about the time I started getting a dozen bills each month also. My local calling area was extended to include the entire state, which has something better than ten million people. No doubt being able to talk to all these people is worth the $90 a month the companies were charging all together. What did annoy me was that since there are twenty times the number of people in the state as in the county, I started receiving twenty times the number of wrong numbers, too.

Then a year ago the entire United States and Canada were placed on local calling status, and my bill jumped accordingly; though with all fairness, the ability of reaching all these people was probably worth the total billing by the 95 phone companies now involved. So I suppose you'd really have to consider $300 a month pretty cheap for all that service. Without wanting to seem like a complainer, though, having to write 95 separate checks a month *was* quite a nuisance. Also, I have to report that at first I expected that since my extended local calling area now reached 25 times the number of people, I expected to get an equivalent increase in wrong numbers. That would have amounted to about 1500 wrong numbers a day. I was gratified to find that the actual number was only half that. I figure that half the people who would otherwise make outgoing wrong-number calls were already tied up answering incoming wrong numbers.

Now we come to the heart of the present problem. I have just received my first set of bills from the phone companies covering the new extended local calling area of the entire world. For a moment I thought the mailman was delivering a phone directory, but of course these days all numbers can be looked up via a modem hook-up from my computer to your central directory systems, at a small extra charge. And again, I have to say that I can't argue with the logic that the ability to reach over five billion people the world over makes the present rate of phone service the best value since the invention of the telephone a century ago. When you think of it that way, $1000 a month is dirt cheap.

Oh, yes, the problem. I can't afford phone service anymore! Also, I don't have the time or physical stamina to write all those checks each month! And what's worse, the line is tied up all the time answering wrong numbers—24 hours a day! CANCEL MY PHONE SERVICE!

Very truly yours,
Jay Kay Klein ■

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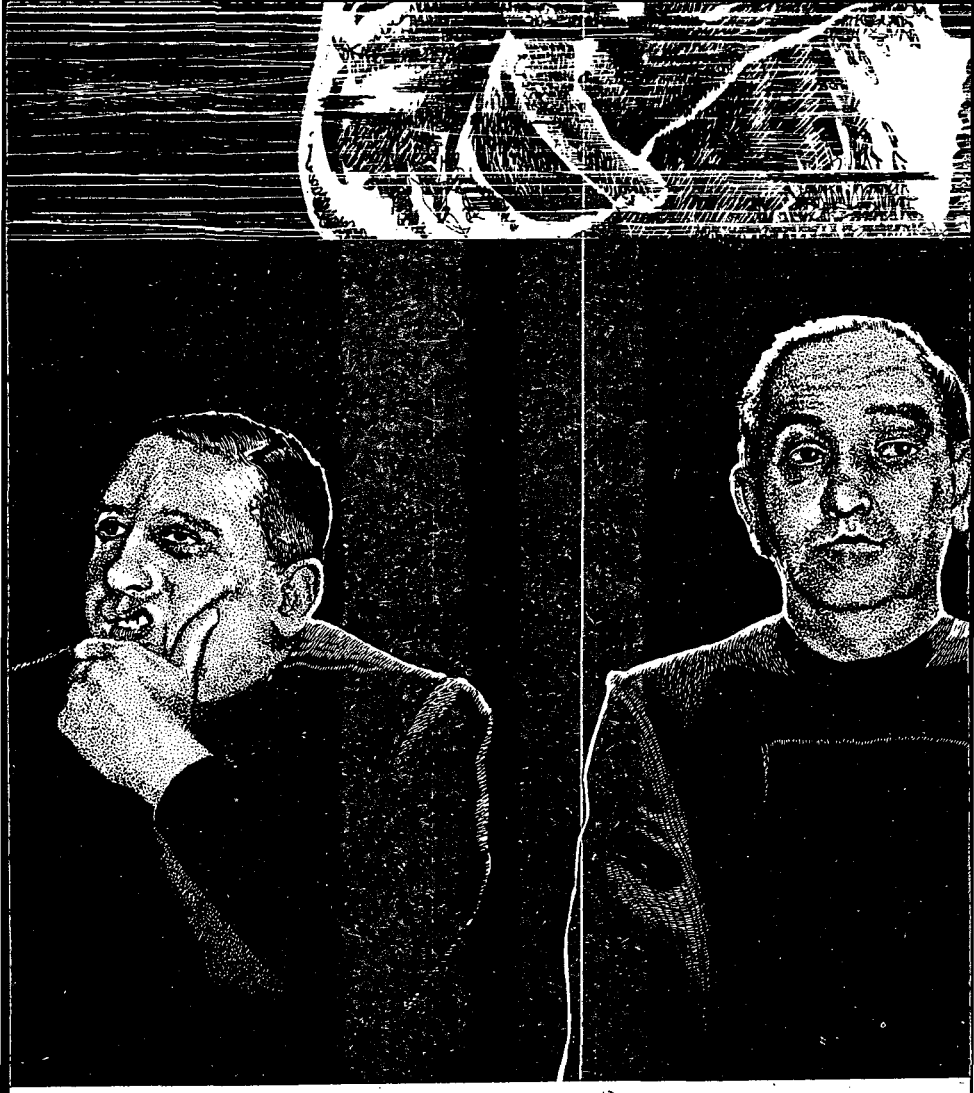

Eric Vinicoff

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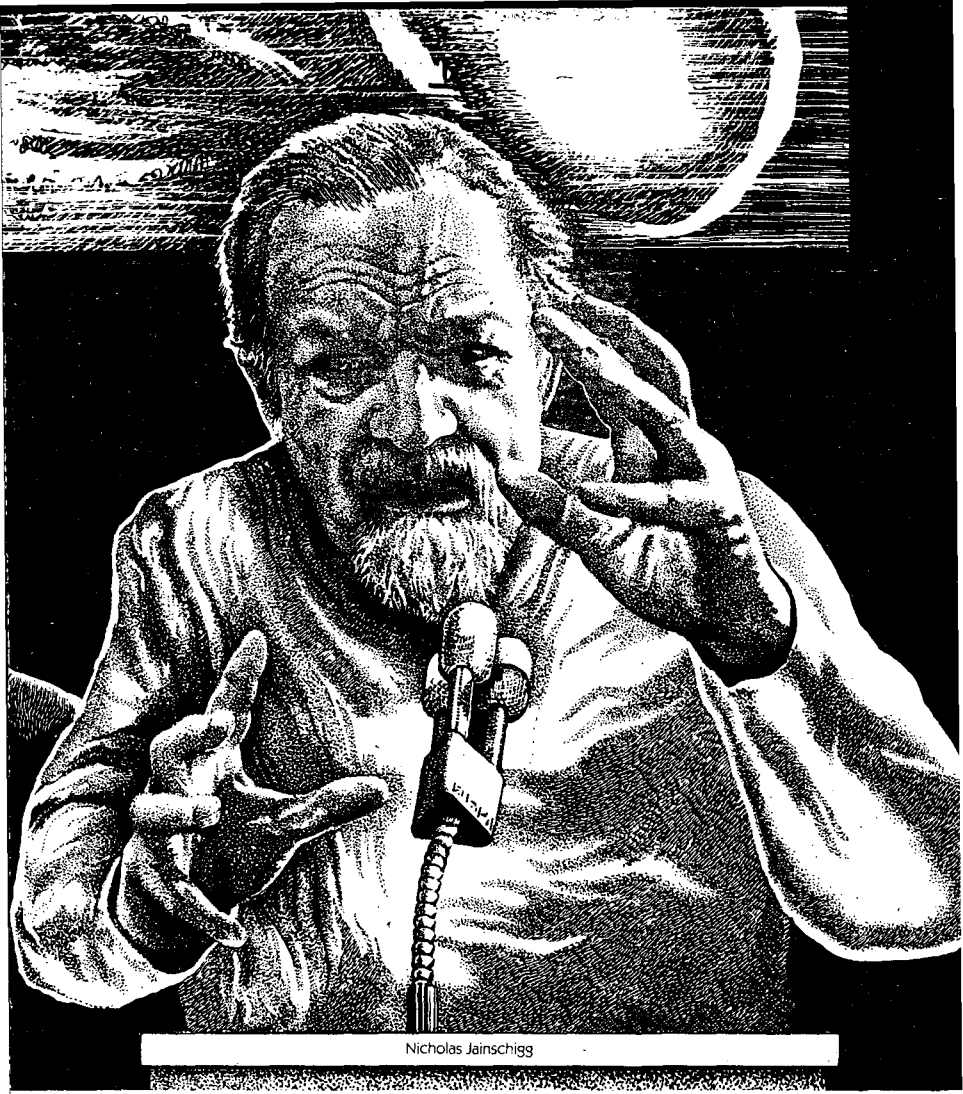

Nicholas Jainschigg

Contrary to what you may have heard,
the message is *not*
necessarily the
medium.

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"And now a few words from our Literary Guest of Honor, Mister Harv Mellis."

Harv hauled his eighty-six-year-old bones out of the chair and walked to the podium. The .8-g made the job easier, but he moved with typical Earth tourist tentativeness. He was short and stocky, and wore a diffraction fabric shimmersuit that was as expensive as it was gaudy. His tanned, wrinkled face showed its age. But his shining eyes and his wicked grin were eternally young.

"Damned few," he began. His voice was a low growl. "I know you all want to go zock your brain tissue with vids and games, and worship at the ceramic feet of your current progger deities. As for me, I'm in dire need of a drink or three."

He looked out at the vast applauding hall. At least ten thousand fans had crowded in for the convention's opening ceremony. For over half a century he had been their Socratic gadfly, and they had been amused. Crueler than hemlock. When they quieted down he went on.

"I stand before you an anachronism, a living fossil. I haven't written a word in over a decade. Therefore you'll forgive me if I feel the honor of your nostalgia less than keenly."

He enjoyed the sudden silence, the concentration on his words. They didn't understand him, as usual, but they didn't want to miss one of his famous diatribes.

"When I was a child there were still a few dramatic shows on radio. I outlived that art form. I outlived television. I outlived the movies. Worst of all, I outlived my own chosen craft — literature."

A few scattered sounds of protest.

"*You think not? I'm not talking about* antique collecting—what was the last *new* book you read? That's a rhetorical question.

"Do you know the most important difference between a writer and a progger? Imagination! Yours! In a book the writer and the reader each contributed some. The experience was unique for every reader. Reading was mental work, active instead of passive. It required a bit of effort. But it was fun, and it was good for you.

"The progger supplies all the imagination. He takes a can opener to your cranium and pours in his vid or game. You just absorb it. A nova blast, sure, but what else do you get out of it? GIGO."

Another round of applause. Everyone was enjoying the castigation, serene in the knowledge that he couldn't possibly mean them. The invincible armor of egotism.

"Okay, so I'm a bitter old man who lived too long. Our beloved genre hasn't died, only a medium of expression. Technological progress allows more precise and comprehensive artistic statements. New forms of entertainment push aside old ones.

"But I don't have to like it. And I don't."

He left the podium. The mindless applause irritated him; he would have preferred thoughtful silence.

Tim Low was fourteen years old, somewhat overweight, and walking in a dream. He had been a fan as long as

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he could remember: first vids, then games. As such he had had one Ultimate Goal: to attend the annual World Convention. It had taken a lengthy campaign of parent-harassment, but here he was.

He was being swept along in the human flow leaving the hall. He had watched the opening ceremony because he was determined not to miss anything, but it had been boring and he was glad it was over. Sitting still had been torture. He wanted to do everything right away. The energy field generated by thousands of fellow fans exhilarated him.

He pushed through the knees and hips and chests to a small patch of untrammeled floor space in the lee of a potted eucalyptus tree. The convention center's foyer was soccer field sized, and still not quite big enough for the milling people, discussion knots, foodvends, registration lines *et al*. The conversational din was impressive.

His parents were off sightseeing, though mother had complained that the *Spacing Dutchman* was little more than a provincial factory town in Earth orbit. He was on his own until dinner. Pulling out his pocket comp, he called up the schedule he had meticulously planned. Good. He had time to check out the dealers room before the Intro to Vid Progging panel.

He got on a crowded walkway. It carried him past the open doors of a big room that had been fitted out as a pub-vid. The bulletin holo said it was showing Wang's latest *Whorsai* saga, about the resource-poor world that exported the galaxy's most skilled women of pleasure. The rows of formchairs were almost filled with people leaning back against the headrest vid elements or sitting up to eat, drink, and talk.

He wasn't tempted. Vids were for plasmoids; games were centered. He was a max player, and someday he would be just as max a progger.

The dealers room was big enough to hold hundreds of tables and stalls arranged in rows, and thousands of people. But what glazed his eyes over and set his heart triphammering were the treasures heaped all around like the booty of a pirate king. Vid publisher displays advertising the latest releases and back-list "classics." Comp gear ranging from microchips on magnifying stands to top-line home vid and game consoles. Book publisher displays offering non-fic and fanpubs. Genre art —mostly light blocks, holosculpts, and paintings. There were even a few eccentrics selling ancient paper books, magazines, and videotapes.

"Hey, Tim!" A hard fist punched him in the shoulder.

He turned, and found himself staring at a skinny chest. He looked up. "That hurt."

He had met Paulo Ramirez while waiting to clear Customs at the shuttleport the day before. Paulo was fifteen and almost a foot taller than he. Paulo didn't speak Chinese and Tim didn't speak Spanish, but their Trade German was good enough to communicate. They had formed the easy alliance of children trapped among boring adults.

"Sorry," Paulo said. "What are you doing?"

"Looking around. You?"

Paulo's usually empty face looked guarded. Which made Tim curious. "Is something going on?"

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"Uh . . . I've got a game tracked. Over at the Miyako-Hilton."

"What game?"

Paulo didn't answer for several seconds. Then he said, "Look, I'll tell you if you promise not to tell anyone. Promise?"

"Okay. Now access."

"Star Pirate."

"Star Pirate! That's a Y game!"

Paulo looked around quickly, but no one was paying any attention to them. "Don't shout," he whispered urgently. "You want to bring the proctors down on us?"

Tim took a deep breath. Y games had hovered ominously and alluringly on his mental horizon for a long time. "You can't play a Y game," he said automatically. "They have the age eighteen law here—it says so in the convention program."

"You can if you find the right gamemaster, and have enough money."

"How much?"

"Fifty marks."

Tim winced. He didn't have much more than that to last the entire week. But his pulse was racing and he felt very warm. A Y game! "I want to play too. Can I come along?" He trembled as he heard his words; he was almost as afraid as he was excited.

"You're too young. It'd scramble your neurons."

"I can take anything you can! And if I play, I wouldn't dare tell on you."

"Come on then," Paulo said. "But if you end up with plasma between your ears, I warned you."

Tim wondered about the too-easy agreement. The reason he came up with surprised him. "You're scared too, aren't you?"

"Wipe that."

But Tim knew better, and for some reason it made him feel less queasy as he followed Paulo toward the exit.

Harv sat at the end of the Earthview Lounge's bar, staring moodily at his second scotch. The floor under his stool legs was crystal with almost the same refractive index as air. Beyond it Earth, Luna, shuttles, spaceships, and myriad stars passed in review as the *Spacing Dutchman* rotated. He ignored the dizzying panorama. All the tourist traps here featured floor ports, and he had lost interest several visits ago.

He had picked this place because it was near the convention center. He wasn't the only one; the bar and tables were crowded with proggers, publishers, and fans. Soundproofing kept the many conversations muted and private, but vid and game deals were being made. He could smell them in the smoke-laden air.

A smooth businessman type oozed onto the stool next to his. "Hello, Mister Mellis. May I call you Harv?"

Harv sized him up. About forty, slender, with cash register eyes. A publisher. The suit was conservative and expensive, but obviously so. A second-rate publisher. Time to sing that same sad old song. "Everyone does. Let's hear the pitch."

The stranger turned on a warm smile and stuck out his hand. "Well, to begin, may I buy you another round? My name is Enrico Bava."

Harv accepted the hand and the drink; Bava had a wine cooler. Then Bava

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went on. "I'm with Sabatini and Company of Naples. Maybe you've heard of us?"

"No."

"We publish games for adventurous, sophisticated adults."

"You're a Y game sleaze peddler."

Bava's smile took on a bit of strain. "We would like to get you to program some games for us. Frankly I'm surprised that you've never done any vids or games, considering your well known skills."

"You weren't at the opening ceremony, were you?"

"No. Why?"

"Access my speech at your leisure. I cast my pearls before swine but once."

"Our advances and royalties are extremely generous—" Bava began, but Harv cut him off.

"Filthy lucre isn't the issue. I don't have anything to say to your brave new universe."

"But games are—"

"Intellectual masturbation. X games are sanitized pap for plasmoids, but they're relatively harmless. Y games are downright unhealthy. Now if you'd care to publish a great novel, we can talk."

Bava shook his head. "You're every bit as hard a sale as I was warned. If you should change your mind . . . " He handed a gold-lettered business card to Harv, who automatically stuck it in his wallet. "It has been a pleasure meeting you."

"Thanks for the drink."

Bava returned to his back booth and his companions. Harv took a gulp from his free drink, and thought some of the bleakest thoughts he owned.

* * *

The hotel suite's door was closed, but Paulo touched the announcer with apparent confidence. Seconds passed, during which Tim suspected someone was looking them over, then a male adult voice asked, "What do you want?"

"We came to see Chris." Paulo's voice broke as he spoke the access code. As for Tim, he was on the verge of warping out. But the door hummed open before his legs could start running.

They walked in hesitantly. The door shut with disturbing finality behind them. The suite's anteroom wasn't large, and it looked even smaller with all the furniture pushed into the front half to make room for a horseshoe comp console and six tall bubble memory cabinets. Cables ran from the console into the two bedrooms. Tim recognized the comp as a five-year-old Osato DD9B. Not a state-of-the-art gamer, but still a commercial mainframe capable of running the most powerful games. His fingers yearned to hack at the banked keyboards.

A woman was seated at the console, her back to them. Chairs were arranged against the walls like a doctor's waiting room, but none of them was occupied. The only other person in the anteroom, a man who looked like a college student, walked over to them. "You kids are in the wrong orbit. This isn't your kind of game."

"We're here to play Star Pirate," Paulo said belligerently.

"You're not old enough."

"Yes we are." Paulo pulled out his wallet and extracted his money card. Tim did the same.

"Can you each afford fifty marks?" the man asked.

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"Sure," Paulo answered for them.

The man frowned down at them. "I want you to think very carefully about what you're doing. This is your first Y game, isn't it?"

They nodded.

"I'm sure you've heard a lot about them, but you don't really know. You can't until you play. Unlike the games you're familiar with, the simulation is total. Nothing is left out to protect the innocent. Now I personally think the age limit is stupid—some people are mature enough to handle Y games at thirteen, others aren't at sixty. So you tell me. Do you still want to play?"

Actually Tim wanted to be anywhere else in the cosmos, but he wasn't going to back out if Paulo didn't. They nodded again.

"Okay, sit down. We'll be set up for you in a few minutes." He ran their cards, then smiled. "If you change your mind and want to do a warp, go ahead. You won't be the first. We'll cancel the fees."

They sat nervously as the man disappeared into one of the bedrooms. "This is going to be great," Paulo said over and over, mostly to himself. But his forehead was damp. Tim tried to imagine what it was going to be like, but he knew he was failing miserably.

The man's head poked out of the bedroom doorway. "We're ready for you. Come here."

The bedroom contained two beds. Black plastic headsets sat on each pillow, attached to the cables from the comp. Tim and Paulo knew what to do. They stretched out face-up on the neosilk bedspreads, and put on the headsets. The man checked them carefully and adjusted the contact elements. "Have good games," he said, and left the room.

Star Pirate was an individual game; so Tim said to Paulo, "Good luck. See you after."

"Same to you."

Tim shut his eyes before the game could do it for him. He was glad the gamemaster looked like he knew what he was doing; there were dark tales about blown games resulting in mindwipes. But it was too late to worry about that.

Any second now the game would—

"Excuse me. I don't mean to intrude, but you are Mister Harv Mellis, aren't you?"

Harv turned his gaze from his almost-empty glass, wearily bracing for another round of publisher-baiting. But it took him almost a second to decide that the man sliding onto the bar stool next to his wasn't a publisher.

The man was nearly as old as Harv, and he seemed older because his face was tanned and wrinkled from hard use as opposed to Harv's biosculpt rejuved physiognomy. He was big and heavily muscled. The gray suit he wore tried to make him look like a businessman or professional, but Harv wasn't fooled. The eyes and body language told a different, less obvious tale.

Harv was curious. "Guilty as charged. Are you buying or selling?"

"You tell me." The man spoke Trade German like a native. Probably Noreuropan, Harv thought. "My name is Hans Bergenholm. I'm an admirer of your writing, and I'd be honored if you would autograph this."

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He handed Harv a book, an actual paper-and-ink book, almost a half century old. It was *Orion Cabaret Blues*—not his best novel, but his favorite. The book wasn't a pristine, probably unread collector's copy; it was ragged and dog-eared. He could have kissed it. He wrote a brief inscription with the pen which Bergenholm supplied, and his mood improved significantly.

"What are you drinking?" he asked as he handed the book and pen back. He didn't want this unusual character to get away before he could fill in some of the blanks.

"A vodka martini, thank you."

When Bergenholm was comfortably settled with his drink Harv asked, "Are you attending the convention?"

"No, I'm here on business. I'm with a pest control firm."

"Pests in space?"

"You would be surprised," Bergenholm said earnestly. "Vermin manage to follow humanity wherever we go. Mind if I ask you a question about your career?"

"I don't mind your asking. I may mind answering."

"Fair enough. I wonder why you gave up writing—*Screaming Space* was over twelve years ago."

"I didn't give it up," Harv growled. "It gave me up."

"I don't follow."

Harv breathed deeply. "Let me take you on a brief, bitter journey down memory lane. What put me out of business was the changeover from paper-and-ink to home comp distribution. The publishers didn't realize, until it was too late, that they had pulled their own plug too."

"They're still producing books."

"Sure. Non-fic and a handful of what we used to call best-sellers. But genre fiction—including my stuff—didn't sell enough copies, so they stopped publishing it."

"But home comp distribution saved the publishers money," Bergenholm objected. "How could it make your books unprofitable?"

"Hacking and sharing. Competition from vids and games had already reduced sales to a marginal level; comp thievery administered the *coup de grace*. Only novels with mass appeal are now financially viable."

"You could put your books on the public nets."

"I have," Harv said sourly, "and my monthly royalties are just about enough to buy a mediocre dinner. No advertising or promotion, ergo no way to attract readers. Being a businessman as well as a storyteller, I knew it was time to retire."

Duncan Starslayer (who knew he was also Tim Low) sat in the cramped cockpit of his fighter. His hands moved expertly over the control panel. He monitored and understood the flashing displays. Beyond the cockpit's glassite dome were stars and space like diamonds on black velvet, and the swollen orb of Betelgeuse pouring out blood-red light. He felt the acceleration of the ion thrusters, smelled the flat recycled air, and tasted the sweat on his upper lip.

The thoroughness of the database impressed him. This wasn't a vid, in which he would have been just a disembodied observer. He had a fully realized identity. He admired his adult body, about

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thirty years old, tanned nut-brown and muscled like Hercules, wearing the black neoleather uniform of an Alliance Commander. He felt the way he imagined such a man would feel—powerful, capable, and dangerous.

He wasn't afraid anymore. He was a gamer, ready for the flight of his life.

The radar screen alerted him. "Tighten up," he said into his throat mike. "We have company. Nine black fighters incoming."

"We see 'em, Dunc." Vagn, the nine foot furry Tarthian, appeared in a viewscreen. He and the lizard-like Slidith were Duncan's wingmen and old friends. "Some fun, eh? Just like that time on Antares VI."

"Lesss talk," Slidith hissed from his viewscreen. "Insssufficient intelligence to ssspeak and fight at the sssame time."

"Why you scaly green—"

"Attack formation," Duncan ordered. "Follow me." He winced as a Tarthian war cry drowned out Slidith's, "Asss you sssay." Their fighters closed in until they were just off his wingtips.

The Pirate Queen's dreaded fighters swept down on them like flaming arrowheads in a V formation. Duncan lined up the lead pirate and hit max acceleration, his wingmen locked in.

Blue particle beams missed the cockpit by a handful of centimeters as he banked hard right to avoid them. His target screen centered on the pirate. Its magnified image showed the pilot, and his hand froze for a moment over the firing button. Then he silently laughed at himself, slapped the button, and his wingtip beams lanced out.

The pilot and his fighter blew apart in a spectacular pyrotechnic display.

He felt no regret over killing a human being, just warm satisfaction at having removed a piece of feces from the universe.

Slidith had a pirate hot on his tail. Duncan pulled a seven-g turn, and the centrifugal force tried to squash him. His vision blurred. But he dove and blasted the pursuer with one well-aimed pulse.

With Vagn's backup he took on two more pirates in a quick but savage dogfight. The fighter moved under his direction like a hawk, dodging, stooping, and striking. He was breathing fast. In seconds his beams turned both pirates into balls of radiant energy. At each kill he felt a thrill like when he masturbated.

"Some fun, eh, Dunc!" Vagn shouted.

"Keep your mind on your job," Duncan shot back, "or these babyrapers will turn your mc^2 into E."

"Sssound advissse. Heed it, fur rug."

The remaining pirates began another attack run. Duncan shot ahead to engage them with a smile on his lips and great joy in his heart. This was the best game ever. X games weren't even in the same cosmos. The excitement of the hunt, escaping deadly (but totally safe) danger, plus of course the max lift that came from winning—he was in rapture.

And he was rolling up a perfect score. Pirate after pirate exploded at the touch of his beams, while he managed, sometimes barely, to avoid theirs. The database told him how, but he was doing it!

Soon the void was empty of pirate fighters. He took several deep breaths and wiped the sweat from his forehead.

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Vagn and Slidith fell in behind him, then they resumed their flight toward Betelgeuse III and their goal.

"Impresssive piloting, Commander," Slidith hissed.

"This calls for a drink," Vagn added.

"When we get back to Base I'll buy you all you can hold, old friend. But don't touch your flask until then." Duncan sat back in his seat and decompressed. He had made it through the first screen, but there were more and harder ahead.

"I'm a modern day Baron Frankenstein," Harv said sourly. Despite the subject he was enjoying the conversation; Bergenholm was an excellent listener. "Haunted, hunted, and ruined by my own creation."

"I didn't know you invented the vid and game technology," Bergenholm commented, smiling slightly.

"I wasn't its father, more like its grandfather. Forty years ago I started a company called Ghost Writer, Inc. I developed a comp program for analyzing literary style and content, and then generating convincing imitations. We did a good business churning out novels by popular dead authors. Later I developed the World Game—ever hear of it?"

Bergenholm shook his head, but the smile remained. Harv had a hunch he wasn't telling Bergenholm anything he didn't already know.

"It was the first program with a human interface. Various experts were wired into the comp to help 'play out' future history extrapolations. Anyway, I published some articles about the Ghost Writer and World Game programs. Yanovich, Grigg, and Isawa used them liberally in their work on passive and participation sensory simulation programs—vids and games."

"Did that make you a rich man?" Bergenholm asked. "The three you mentioned certainly are."

"Would I be hustling drinks in this tourist trap if I were rich? The court decided that my contribution wasn't 'integral.' Translation: they could afford better lawyers."

"You make yourself sound like the protagonist in a Greek tragedy."

Harv felt a quick surge of anger, then laughed. "All artists are tragic figures. Actually I haven't done too badly with this strange gift called life. I'm just sorry to be looking back at mine, not ahead."

"Aren't you writing your obituary somewhat prematurely?" Bergenholm asked. "You look like you still have a few useful decades in you."

"Maybe. But what should I do with modern medicine's largess? These days I'm exploring the potential of alcoholism as a lifestyle."

"That would be a sad waste of a great talent," Bergenholm said.

Harv tended to agree, but he couldn't see any preferable alternative. He raised his glass. "May I propose a toast. To the art of literature. R-I-P."

Bergenholm lifted his own glass in silent sympathy.

The fortress of the Black Queen was an enormous crystal dome in the ice-bound polar wastes of Betelgeuse III. Duncan and his two wingmen dove toward it unannounced but not unexpected. A barrage of particle beams

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from the rim batteries met them, and only some very fancy piloting brought them through intact.

"How are we going to get inside the dome?" Vagn asked. "They aren't going to pass us through the ship port even if we ask them nicely."

"Follow me," Duncan ordered, and headed straight for the dome. An instant before crashing into it he spun 180° and fired his thrusters full blast. The ion streams blew a patch of the crystal into shards. The three fighters dropped through.

They hovered over the cradles supporting the Black Queen's fighters, and cut loose with their particle beams. In seconds the fleet that had terrorized the galaxy was reduced to lumps of twisted alloy.

The spectacle of fires, explosions, deafening noise, and the screams of the dying held him spellbound. He saw a pirate running across the field, burning like a torch, the flesh blackening and falling off of the bones. He almost threw up before he remembered.

"Blast every building but the palace," he ordered, his joy returning as he got his mind back on the game. This they did quickly. "Now down before the survivors reorganize."

The fighters landed in the gardens in front of the golden-veined marble edifice which was the Black Queen's palace. A half-dozen pirates crouched near the entrance; pulses from their laser rifles were clawing at the fighters' hulls.

Duncan fired one of his wingtip particle beam cannons. The pirates exploded, as well as the entrance. "You two cover me," he said, "while I go arrest her majesty."

"Take care, Commander," Slidith hissed.

He laughed. "I think we're in the wrong line of work for that."

Leaving the fighter, he ducked through the ruin of the entrance and followed an opulent hallway to a broad stairway. He ran up it, and found himself on a slick marble floor facing five meter high doors of silver inset with various gems. He skidded to a stop.

Four guards stood in front of the doors, scarred and grinning brutes who made Vagn look like a dwarf.

They drew long black swords. The biggest pirate stepped forward. "You came close, Starslayer, but this is where it ends for you."

Duncan ignored the gun at his side, and drew his own sword. "Let's see if you fight any better than you smell."

He advanced coolly enough, but as the first glistening blade swung toward his neck he froze in mute terror. His imagination leaped ahead of his intellect, feeling the cold metal slicing his skin and muscle and bone. . . .

He snapped out of it and parried the cut barely in time. A moment later the fight was four against one, and his fast-moving sword wove a shield which none of the pirate blades was able to penetrate. He had to concentrate totally on defense; it took every bit of his skill just to stay alive. He was sweating freely and bleeding from a few minor (though painful) wounds.

Then, as he mastered the pirates' attacks and his counters became automatic, he started to take the fight to them. Mere survival wouldn't win the game.

One of the pirates didn't bring his

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sword back far enough after a thrust. Duncan spotted the slight opening and took advantage of it in the same instant. He sliced as hard as he could at the pirate's unguarded right thigh.

The sensation was like pulling hard on an oar as his blade totally amputated the leg.

The pirate's face locked in terrible surprise, then he fell over and hit the marble floor with a limp thud. The severed leg landed on top of him. Blood spurted from the main artery in bright red pulses of rapidly diminishing vigor. Some of it caught Duncan across his face; it tasted salty and smelled like sheared copper.

The remaining pirates took a few moments to get around their dead comrade and resume the fight. That was fortunate for Duncan, because he was too busy staring at the corpse and keeping vomit down to defend himself. He felt like he might faint.

But he didn't. It's not real, he told himself over and over, and pulled himself together in time to fend off the renewed attack.

The challenge took his mind off what he had done. As he fought the sickness faded, overcome by the excitement of the game. He slipped back fully into his role. These murdering pirate feces deserved butchering if anyone in the universe ever had.

When minutes later he killed a second pirate with a thrust through the heart, he only felt a little bad. The third and fourth deaths were victories that warmed him with satisfaction.

"But enough about me," Harv said—a phrase he rarely used, since he rarely exhausted his favorite topic. But he was still curious about Herr Bergenholm's strange *ka*. "Let's talk about you."

"Why?" Bergenholm smiled disarmingly. "You're the famous writer. I'm just one of your fans."

"The *Spacing Dutchman* is a pretty big place, and conventioneers are all over it like mold on old bread. You must have a knack for finding people."

"I have an orderly mind. I eliminated everywhere you wouldn't be, which left only a handful of places for me to check personally."

Harv liked obscure answers; most people these days were as direct as they were uninteresting. "Why is it I don't believe you?"

Up went Bergenholm's thick black eyebrows.

"You're very plausible, Herr Bergenholm. But I've spent a lot of years observing *Homo sapiens* so I could write intelligently about us. You add up to two different people, the one you want to come across as and the one you really are."

"Your mind seems to be running on too rich a fuel mix," Bergenholm said cheerfully. "But this notion of yours is interesting. Please tell me about this second person, the real me."

Harv frowned. He didn't like being ridiculed, no matter how nicely it was done. "You're a hunter of some sort. Your body language shows sharp reflexes despite the ethanol, and total awareness of your environment. Your conversation is skillfully crafted, a bit too much so to be real. People have more rough edges. Care to tell me what—or whom—you're hunting?"

"Why can't I just be a businessman

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having a friendly chat with his favorite author?"

"You can be anything you want. It's your life. But I'm a curious drunk, and we've been 'chatting' for an inordinate length of time. Are you expecting something to happen?"

"Now you're guessing," Bergenholm said, his amused expression still in place. "As it happens, I'm waiting for a lady friend to get off work so we can go to dinner. I'm enjoying our conversation very much, but if I'm imposing I'll take my drink to the other end of the bar."

Harv wondered if he would actually leave, but decided not to risk it. "Not at all, my mysterious friend. It beats drinking alone. But be warned—I intend to keep peeling away the onion-layers of your identity."

"You're more than welcome to try."

Duncan blasted the jeweled door from its hinges with his laser, and jumped over it into the room beyond. He froze.

Not because of the room, although it was the biggest and fanciest bedroom he had ever seen in reality or fantasy. The rugs on the marble floor were exotic furs; the walls and pillars glistening silver. The ceiling was a dancing mosaic of gems from a score of worlds. An enormous silk-draped bed dominated the furnishings. Soft lighting set a sultry mood, and perfume scented the air.

What stopped him was the room's sole occupant. The Black Queen stood near the bed, looking at him with an alluring smile. She was of Eurasian ancestry, tall, slender around the waist but large-breasted. Her oval face with cat-slitted green eyes and a small mouth was framed by a waist-length cascade of black hair. A tight garment of neoleather strips and gold chains covered very little of her body, and hid nothing.

All of his pubescent half-understood feelings about girls erupted, choking him with excitement and fear. This was the legendary Y game final screen which his peers discussed in hushed whispers. The ultimate challenge, as well as the victory prize.

He took deep breaths and tried to calm down. There was nothing to be afraid of. None of it was real; he could do anything he wanted to. And no one would ever know.

He could have turned and left, but he didn't. He was too much of a gamer to quit. He wanted to win. And with a sudden hot rush of certainty he knew he wanted the prize too.

"Welcome, Commander Starslayer," the Black Queen said in a voice like wind chimes. "It seems you've breached all of my defenses. What are you going to do with me?"

"I'm taking you into custody," he said firmly, walking over to her. "You'll get a fair trial and a painless execution."

She leaned against him, running her soft hands up his broad chest and around his neck. Her hair smelled so flower-sweet that his knees almost unhinged. He felt weak, and he had to gasp for air. The database told him what was happening to him, but that didn't make it any less scary.

"You may have beaten my underlings," she murmured in his ear as she kissed it, "but you haven't defeated me. No man ever has."

"Until now." His left arm went around her, while his right grabbed her

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hair and jerked her head back. As her mouth opened in surprise he kissed it brutally. A wonderful sensation shot through him. She fought, but that only made it better.

She tried to knee him in the groin, and claw his eyes out with her long black fingernails. He hit her hard enough to knock her back onto the bed and glaze her eyes. The sick-sweetness he felt from hurting her changed something inside him forever.

He leaned over and tore the garment from her body. For a few seconds he was lost in mute admiration, then he took off his uniform. She tried to jump off the bed, but he pinned her to the silk sheets.

The scents of perfume and woman were maddening, and the touch of her flesh against his shattered all thoughts but one. Driven by his new hunger and guided by the database, he did what he wanted to do to her. At first she resisted. But soon she was cooperating with a passion that matched his.

A long time later he rose from the tossled bed and got dressed. She was smiling up at him, half-asleep.

"Come on," he said crisply. "You have a date with the lethal chamber."

"You bastard!" she screamed, her face twisted by rage. She dove for the doorway, but he caught her and knocked her unconscious. Slinging her over his shoulder, he started back to his fighter.

He had won the game.

"Excuse me," the bartender said. "Herr Bergenholm?"

Bergenholm nodded.

"There's a call for you, sir. The phone is at the end of the bar."

"Thank you." Bergenholm headed for the phone, and Harv took advantage of the conversational break to order another round. *In vino veritas,* or at least looser tongues. But so far the Noreuropan hadn't dropped any clues despite an impressive intake of ethanol.

Bergenholm returned quickly. "That was the lady with whom I should now be beginning the second course of a fine meal. She's running late at work, and wants me to pick her up on the way to the restaurant."

Harv was sorry to hear that, but accepted the end of his little game graciously. "Well, it's always a pleasure to meet a fan. Particularly one with something more than plasma between the ears."

Bergenholm stood up, apparently about to say goodbye, then changed his mind. "If you're free, how about joining Andrea and me for dinner?"

So it isn't over, Harv thought, and smiled inwardly. "Won't your friend be upset if you drag me along to your tête-à-tête?"

"Not at all. She loves to meet celebrities, and she would probably be upset if I didn't share you with her."

Maybe she could answer some of his questions about the mysterious Herr Bergenholm. "Since you put it that way . . . " Harv slid off his seat, and followed Bergenholm out.

Standing on the sidewalk under the holographic evening sky, Bergenholm summoned a cab. The ride was a short one, ending at the Miyako-Hilton hotel across from the convention center.

When the lift opened at the sixth floor they were stopped by a proctor, very impressive in his black and silver uni-

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form, who politely asked if they were staying in the hotel. Bergenholm whispered something to him, and he gestured them on without a word.

Bergenholm led the way along a tastelessly elegant hall to an open suite doorway. Two more proctors stood in front of it. Harv's suspicions about his drinking companion's vocation were crystallizing fast. And he was beginning to wonder about the "lady friend" too. This was getting better and better.

Bergenholm didn't even have to whisper to these proctors; they both stepped aside, and Harv and he entered the suite.

The first thing Harv noticed was the big computer at the far end of the anteroom. A gamer mainframe, hardly state-of-the-art but serviceable. There was only one plausible explanation for its presence. Someone was running an unlicensed Y game, or rather had been—it was crashed now.

The young man and woman handcuffed and seated with a proctor watching over them had to be the gamemasters. They didn't look like the usual unlicensed sleazoids; probably a pair of max gamers with underdeveloped senses of responsibility.

The door to one of the bedrooms opened, and two proctors came out. One was a strikingly beautiful woman with more braid and stars on her uniform than any of the others. But Harv only noticed this peripherally. His attention was grabbed by the two boys between the proctors.

The Chinese boy looked at him as they passed, and he saw the eyes reflecting the soul behind them. His breath caught. They were old eyes, experienced and cynical. They knew things no boy's eyes should ever know. He had seen their like before, as a young soldier in a country ruined by war. The eyes of street urchins forced into adulthood before their time, with no morality beyond self-interest.

But this wasn't a war victim. He looked like one of the young fans swarming through the convention, the beneficiaries of the wealthiest and most peaceful period in history. Except for those eyes.

Harv felt sick.

The boys were taken out of the suite by the other proctor, while the lady walked over to Harv and Bergenholm.

"Harv," Bergenholm said, smiling rather grimly, "may I present Contessa Andrea di Samario, the proctor-in-chief of the *Spacing Dutchman*. Andrea, this is Harv Mellis, the best author of our century."

"Why limit it?" Harv said automatically, taking her offered hand and kissing it. "I'm honored, Contessa."

"Andrea, please," she said. Her voice was a soprano melody. "I'm afraid you've caught me at a particularly ugly moment. I apologize."

"No need." Harv paused. "If I may ask, what's going to happen to those kids?"

"They won't be arrested." The Contessa frowned. "They're considered victims, not criminals. We'll take statements and return them to their parents with a recommendation that they receive therapy."

"Trying to put Humpty Dumpty together again," Harv growled. The Contessa looked puzzled.

"Andrea," Bergenholm said, "I've

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taken the liberty of inviting Harv to join us at dinner. Do you mind?"

"Quite the opposite." She smiled dazzlingly. "I can leave now; the team has this situation secured. Shall we?"

Bergenholm took her arm, and Harv walked on her other side as they left the suite. He was damned glad to get out of there.

A valet brought her car—a showroom-new Ferrari Lectra—to the lobby entrance. The drive to the restaurant was made in silence, and Harv used the time to sort through the new data.

Bergenholm's lady friend was the local police chief. Interesting. He felt a twinge of guilt, but quickly relaxed. He couldn't think of any law he had broken lately, certainly not a United Nations law.

How likely was it that a visiting businessman would be romantically involved with a lady cop? Not very. So Bergenholm was probably in the same line of work himself, sailing under false colors. Why? Was all this really a chance encounter, or a setup of some kind?

He had a hunch he would soon know.

The restaurant looked promising, unlike the tourist traps in the hotel district. They were smoothly installed in a private booth. As the dinner progressed, Bergenholm and the Contessa engaged him in small talk that was entertaining but carefully guided away from the topics of interest to him. The food was excellent.

Finally, as they lingered over liqueurs, his hosts maneuvered the conversation to the pre-dinner arrests.

"Y games," the Contessa said bitterly. "They're unhealthy enough for adults. But what the unlicensed ones do to the children who play them is a tragedy. You can't imagine—"

"You underestimate my imagination," Harv cut in, remembering those eyes. "I've read some articles on the subject, since I have a fatherly interest in the use—and misuse—of the technology."

"Sometimes I think we should ban Y games totally, licensed and unlicensed."

"Simplistic answers are usually wrong," Harv objected, feeling his instinctive anger at any attack on the First Amendment. "I agree that Y games are feces, a bloody minded abuse of a new artform. But outlawing free expression is worse."

"You don't realize how bad the situation is," Bergenholm said. "Y games are so new that the damage they do to children is only now becoming clear. And they're so popular that the problem is worldwide.

"The psychologists say it's a matter of negative socialization. The emotional reactions generated by the games are so strong that they overwhelm the child's incomplete moral imprinting, resulting in unhealthy attitudes toward love, sex, violence, personal gratification, *et al.* These attitudes are dangerous to the child, and ultimately to society as well. A generation of such children could tear apart the very structure of our civilization."

Hyperbole rarely impressed Harv, but this time he made an exception. The soulless young would in time inherit the world. And do what with it? What image of their distorted values would they create?

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"Sounds like you have a big job ahead of you stopping the unlicensed Y games," he commented. "I hope you're up to it."

"We aren't," the Contessa said flatly. "And I'm speaking not only for the UN proctors, but police everywhere. The hardware and software are too commonly available to be effectively regulated. And the free expression issue keeps us from taking some steps that would help."

"The damage isn't done by the games *per se*," Bergenholm said, "but by the values they teach. The proggers go for the most visceral emotions to boost sales. That means lots of sex and violence and gutter morality. Too bad the more socially responsible games aren't very popular."

"That's because they're sanitized pap," Harv snorted. "Kids want to know about sex and violence. Which they should—they're important subjects."

"I have no quarrel with that," the Contessa said, surprising Harv. "No matter what parents and police do, some children will always find a way to sample the forbidden fruit. It's what they learn about those subjects that frightens me."

The conversation paused awkwardly.

"We can't make the proggers put a moral context in their games," Bergenholm said at last. "Too bad someone can't beat them at their own game, so to speak."

"Say what?" Harv asked.

"Outdo them. Create a line of Y games with healthy attitudes toward sex and violence, but so exciting that they drive the others out of the market. Or at least reduce their sales—and therefore our problem—significantly."

"A neat trick, if you can pull it off."

"Why not?" the Contessa asked. "Adventures can have motivations other than hate, rewards other than rape. Pain and death can be shown as the ugly things they are. Sex can be part of good loving relationships."

Harv thought about it for a few moments. "The dark side of the soul has a powerful fascination, even in the hands of second-rate proggers. It would be very hard to beat that."

"But a creative genius and master progger might be able to do it," the Contessa said. "The experts we consulted all suggested one—and only one—such person."

So it was a setup. He considered getting angry and storming out, but decided not to. Not yet. "Okay, folks, before this goes any further everyone takes their masks off. I'm Harv Mellis, retired writer. Now you two?"

Bergenholm and the Contessa looked at each other, and the Contessa nodded. Bergenholm said, "The names are correct. Andrea is the local proctor-in-chief, but in this matter she's acting on behalf of the World Health Organization. I'm an operative on loan from Noreuropan Military Intelligence."

"And you've never read a damned word of mine, have you?"

"If it had been necessary I would have, to prepare for the mission. But as it happens, I really am an admirer of yours."

"Our purpose was to put this proposal before you in the best possible light," the Contessa explained. "Your well-known stubbornness and hatred of games

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made a direct approach inadvisable. If we've offended you, we apologize. But please don't punish the children for our mistake. Will you program the line of games for us? We can promise you a very generous contract."

"Give it a rest, lady. I don't hold anything against you two—you've provided me with an excellent dinner and an interesting evening. But I'm not in the thought control business."

"We just want you to present the moral beliefs we know you hold as persuasively as possible. Isn't that what writers do?"

Bergenholm was smiling. "What are you so happy about?" Harv demanded.

"I'm just enjoying the show. Relax, Andrea. He's going to do it. He has to."

"And why is that?" Harv almost snarled.

"Because you don't like what your technology is doing to children. Because retirement is just being useless. But mostly because if you don't try, you'll never know whether you could do it."

Harv stood up. "Contessa, I respectfully decline your offer. And bid you goodnight. Hans, you should know from my books that I hate being predictable."

But he could feel Bergenholm's smile at his back all the way to the door.

Harv lay on the bed in his hotel room, staring at the ceiling. He had set it for storm clouds to match his mood. Now he watched lightning flash across the holographic sky, and thought more clearly as his anger oozed away.

Finally he sighed. Taking out his wallet, he dug through it and came out with Enrico Bava's business card. If he was going to dance to the UN's tune, he would at least choose his own partner. And it would be fun hassling the sleaze peddler—just like old times.

As he waited for the bedside phone to put through the call, his mind ran ahead into the over-universe of imagination that he hadn't visited for so long.

It was good to be home again. ■

● The six most important words in our language are: *I admit I made a mistake.* The five most important words are: *You did a good job.* The four most important words: *What is your opinion?* The three most important words: *If you please.* (Or, depending on the situation, *I love you.*) The two most important words: *Thank you.* The single most important word: *We.* And the least important word: *I.*

Anonymous

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W. R. Thompson

HISTORY LESSON

Some things don't change—but only some.

Matt Chew finished grading the galactography homework around second sunset. Setting the papers and hand-drawn maps aside, he decided that he needed a short break. The start of a new school term was always a hard time for him. The children, just back from their vacations, still had their minds on playing polyball and coriolis catch. Grinding through their lessons, learning to train their minds—that was *work*, and most of them hated it. They always made certain that their teacher knew that, too.

Chew admired the scenery outside his window for several minutes. Then, with a sigh, he reached for the sheaf of history papers. The teacher glanced at his noteplate to refresh his memory of the assignment. Ah, yes. *Read the first chapter of Introduction to Modern Human History. Write a paragraph which discusses some topic from the chapter. Ask a question about the topic.* And don't expect too much from a bunch of ten-year-olds, he added silently. He had never seen a class that didn't have troubles with its first assignment of the term.

Low as his expectations were, Chew found that the first paper disappointed him. *I read the chapter*, Leni Ulianov had scribbled. *It discussed a lot of major topics. The chapter answered all of my questions about the twentieth century, so I don't have to ask anything.*

Don't answer a question by rephrasing it, Chew wrote on the paper. He set it aside, and read Dora Kaplan's paragraph. *The chapter was boring. Who cares what happened a thousand years ago on a planet a hundred parsecs away? Anyway they were all dumb, because they didn't have robots or starships or anything. Why did the book waste a whole chapter on the twentieth century?*

Her honesty was refreshing, Chew thought, but her answer just wouldn't do. He jotted a note on it, then went on to the next half-legible paper.

They had lots of wars back then, Palipili had written. *The book doesn't say what a war is. I asked my computer, and it said that a war was a woman who did sex for money.*

Check the glossary in the back of the book, Chew wrote, shaking his head. Short answers, hasty scrawls—the kids

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weren't lazy, but they weren't interested in spending their time on their lessons.

Society was in turmoil, Khela-5 had written. *There were lots and lots of wars, but I don't understand. Why should people fight over just part of a planet, especially things as small as Europe and Indojapan? And how could the psychists and civil-service computers approve of leaders like Stalin and Hitler and Mao? I think that the book must be wrong, because nobody could ever be as silly as the book says they were back then.*

Chew took the next paper, and spent several minutes deciphering Ho Lumumba's scrawl. *The chapter says Earth had terrible race problems in the olden times, because all the races hated one another. I don't see how, though. I mean, we didn't meet the Gesticky or the Golightlies until the twenty-third century. So if there was only the human race on Earth, how could there of been a race problem?*

Kids, Chew thought. When one of them finally asked an intelligent question, it *would* have to be one without a quick answer. Not that Chew felt he had a satisfactory answer for that question.

The next paper was another disappointment. *They had a three world war back then, because Earth and the Martian and Lunar colonists got mad at one another. Finally Earth beat Mars and the Moon. Then they launched starships, which is how we got here, so I guess the twentieth century was an important time after all.*

Chew looked up from the paper. Why didn't I become a qualften, he wondered, like the aptitude tests said I should have? But at least there were only two papers left . . . and both of them were neatly written.

They had serious trouble with the environment on Earth, Jhonis Kol had written. *This was because of the environmentalists, who protested and made trouble when they should have been doing their jobs. My mom says that, if the environmentalist on* her *ship had ever carried on like that, she would have kicked his butt out through the nearest airlock. Why didn't the people on Earth keep their environmental technicians from making so much trouble? And anyway what sort of a planet needs environmentalists to keep it habitable?*

That left just one paper. Relief is in sight, Chew thought.

The twentieth century was a time of wars and disasters, so it was a bad time for the human race. However it was also a very important time. This is when people started to travel in space, so this is when human history really begins. The chapter says little about this, because it talks mostly about Earth. However, it has a picture of a plaque which the very first spacers left on the Moon, so I know that the first man landed on the Moon in July 1969 and his name was Richard Nixon. I don't know if he stayed, though.

Finished at last, Chew put his hand on the deskbar and dialed himself a stiff jolt of relaxation. When he considered the fact that this had been the first assignment of the term, he realized that the kids could have done much worse. He would see to it that they did better when they studied the twenty-first century, which was when the *important* things had begun to happen. ■

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Jay Kay Klein's biolog

William Roch Thompson is one of *Analog*'s newest writers, yet he's in its oldest traditions: a long-time reader with a hard-science education who sits down one day and starts writing the kind of fiction he's always liked. Most readers-turned-writers do one or two short stories or perhaps a handful before going back to the nuts-and-bolts of an engineering lab. Some go on to real writing careers. Bill's first story, a short in the Mid-September, 1983 issue, reads very much like the traditional *Analog* engineering-problem story that is so beloved of its readership, with the back of the hand to organizational bureaucracy.

Whether Bill writes full time will depend on just what happens now that he is finally out of school. Living in Los Alamitos, next to Long Beach, CA since age four, he spent several years at the University of California at Irvine and Los Angeles as a physics/astronomy major, transferring to the CSU system at Long Beach where he switched to history. A B.A. resulted in 1982 and an M.A. in Modern History in December of 1984. He finds history just as fascinating as science, but private industry and even academia have nowhere near the capacity for absorbing history graduates that they do for math majors.

A favorite pastime is building model spacecraft out of odds and ends, and models of machines that appear in his stories. Another off-hand activity that is likely to pay off in fictional currency is "Soviet-watching." He got interested in this while taking a course on modern Russian history. He reads obscure government news bulletins, listens to Radio Moscow, and analyzes the precise way in which statements are phrased. He views this as an exercise in applied science fiction, with the Russians a great alien culture to study.

When he learned to read at six, his parents discovered they could keep him out of trouble for hours by giving him a book. The first non-school book he read was a science fiction novel given to him by his grandfather, a long time reader of this magazine. In repayment, Bill named the central character—Dubois, of his first stories—after him. With more experience, Bill expects to branch out with something longer and more complex than these. Like many writers, he finds the characters seem to have lives of their own. He will outline a story, but it generally winds up taking totally unanticipated paths. Eventually, a word processor will be a tool of choice. Right now, he's using an electric typewriter, but once when it malfunctioned, he wrote a story on a manual machine. He notes that his index fingers were sore for a week. ■

W.R. Thompson

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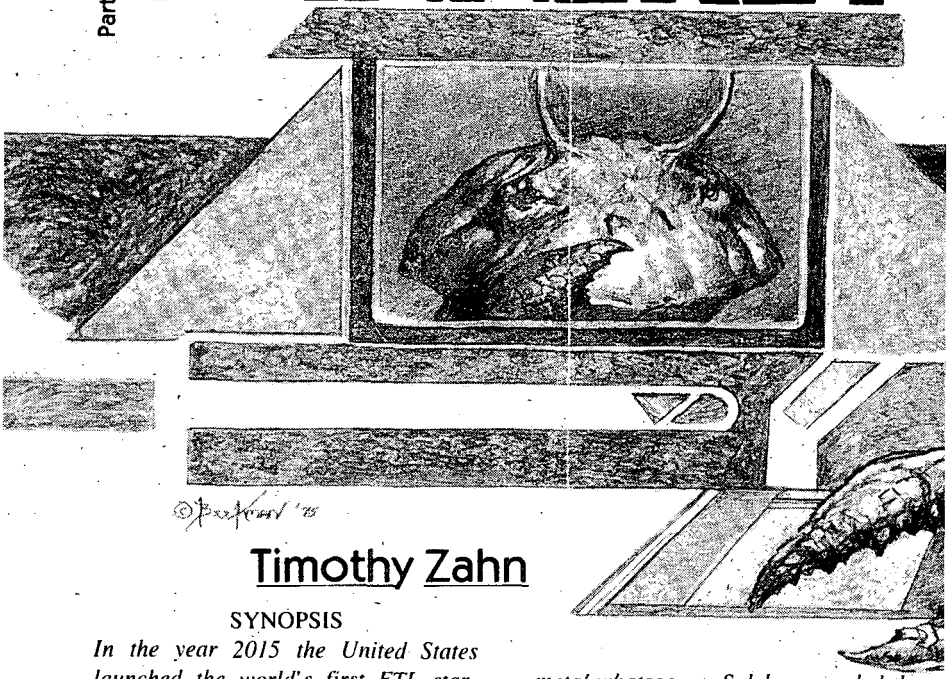
Part Two of Four

SPINNERET



Timothy Zahn

SYNOPSIS

In the year 2015 the United States launched the world's first FTL starships, the **Aurora** *and* **Pathfinder**, *their mission to find new worlds for a crowded and increasingly demoralized Earth to colonize. Their findings were a shock: virtually all oxygen-water planets were already occupied, most of the nearest by one of six different alien empires. One of those races, the* **Ctencri,** *made quick contact with this newcomer to interstellar travel; through them, UN Secretary-General* **Hammad Ali Saleh** *learned of one world that might be for sale or lease. Located within the boundaries of* **Rooshrike** *territory, the planet was considered useless because it contained no detectable metal whatsoever. Saleh persuaded the rich nations to help fund a colony there, while Soviet goading of U.S. President* **John Allerton** *resulted in Allerton's accepting a UN mandate for the development of the new world.*

Ten thousand American scientists, soldiers, and workers were the first colonists to move into the four hastily constructed villages on the world now known as **Astra.** *Among them were the colony's director,* **Colonel Lloyd Meredith;** *a civilian worker on his organizational staff,* **Carmen Olivero;** *a geologist,* **Dr. Peter Hafner;** *and a Hispanic activist,* **Cristobal Perez.**

From the very beginning the colony

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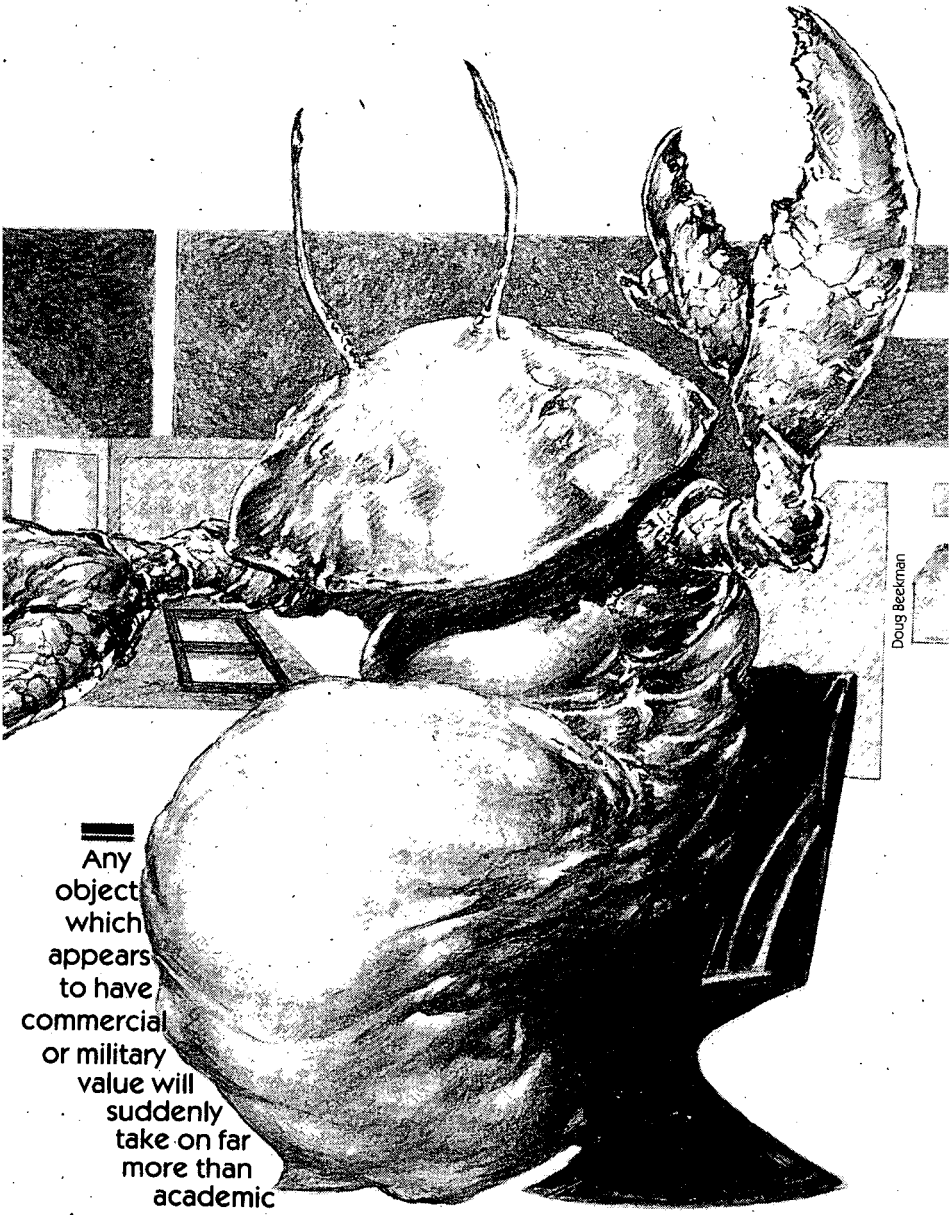

Doug Beekman

Any object which appears to have commercial or military value will suddenly take on far more than academic interest—whether anybody understands it or not.

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was beset by disasters. On the colonists' first full day on Astra one of their three Ctencri-built flyers abruptly lost all power in its plasma-jet repulsers and crashed just south of **Mt. Olympus,** *a dormant volcano about thirty kilometers east of the olony. Then, later the same day, a confrontation between some of the predominantly Hispanic field workers in the farming village of* **Ceres** *and the military authorities there was broken up by stunner fire ordered by the local commander,* **Major Dunlop.** *Meredith was furious at his subordinate's quick use of force and took a team to Ceres to investigate. Perez, mistakenly labeled as one of the mob's leaders by Dunlop, refused to talk to Meredith, but was more open in private conversation with Carmen, who had come with Meredith's investigative team. She was stunned by Perez's allegations that many of the Hispanics had been lured into joining the expedition by unfair promise/pressure tactics back on Earth, but simultaneously annoyed by his veiled threats of more trouble if some of the restrictions of military rule weren't eased. Still, in talking later to Meredith, she suggested that he set up a civilian advisory council to give at least the illusion of democracy to the colony. He refused, but agreed to address other issues of unfairness Perez had raised.*

The next day's work had barely begun when an unexpected visitor arrived: **Beaeki nul Dies na,** *one of the Rooshrike from whom Astra was being leased. Meredith gave him a tour of the colony, learning a little about the six-race—or seven, counting humans—trading association in the immediate area. He also learned the Rooshrike maintained a mining base on the hot innermost world of the system and suggested the aliens might want to purchase some of Astra's sulphur once production began. Beaeki promised to pass on the suggestion and left.*

As the first week passed and tensions re-emerged Carmen again began pushing her Council suggestion; but this time she received unexpected support. Hafner, trying to get a flyer to do studies on the Mt. Olympus volcano, agreed to try and build support for the plan among Astra's scientific community in exchange for Carmen's help in getting flyer priority. Meredith, succumbing reluctantly to the added pressure, allowed the Council's formation—but placed Carmen in charge of it, all organizational work on it to be done in off-duty hours. Perez, pleased that his nudges had borne even limited results, succeeded in gaining one of the Council's ten seats.

Keeping her promise to Hafner, Carmen flew him herself to Mt. Olympus, but the results of his study merely deepened the mystery of how an entire planet could form with no metallic elements in its crust.

And then, a month later, all semblance of normalcy abruptly disappeared. In a single afternoon all metal in contact with Astra's surface simply vanished, melting into the ground as if into quicksand. The effect lasted three hours and ended as suddenly as it had begun.

For the already financially strapped colony, the loss of so much equipment was a thorough disaster. Meredith debated with his senior officers about whether or not they should close down

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the colony and return to Earth, citing in particular the loss of vital trace metals from the fertilized fields. Hafner, describing various geological findings, suggested that the "leeching effect" had occurred several times throughout Astra's history and was, moreover, tied somehow to the mysterious Mt. Olympus. Meredith gave his permission for an expedition to study the volcano, and dawn the next morning found Hafner, Perez, and three others climbing up the slope, while Carmen and one other waited below in their flyer.

But halfway up they suddenly realized that, inexplicably, gravity seemed to be decreasing. Air rushing past them, they headed back down . . . only to find their way barred by a region of heavy gravity that threatened to crush anyone who crossed it. Trapped, their air supply vanishing off into space, they waited for death.

PART TWO

"Peter! Cris! Anyone!" Without taking her eyes off the group lying motionless on the ground, Carmen slapped the radio selector switch. "No response, Colonel. I don't know whether they're dead or just unconscious, but I can't wait any longer. I'm going in."

"Take it easy," Meredith's voice came back, soothing on top, combat-ready underneath. "Flyer Three is scrambling now—"

"No time, sir," Carmen interrupted. "Cross your fingers." Without waiting for a reply, she kicked the underside repulsers to life and eased on the main engines. Hovering a meter or two off the ground, the flyer swung around and drifted cautiously up the mountain toward the trapped expedition.

It was a nerve-wracking trip, caught as she was between the need for haste and the need for caution. She had no idea where the near edge of the high-g ring was, and if she hit it too fast she could easily lose control and ram the

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flyer all the way in. Licking dry lips, she kept going, peripherally aware of Sadowski sitting tensely in the seat beside her. The others were ten meters away now . . . seven . . . four . . . the hole the hammer had made was visible—

With a snap of sheared connectors and the boom of a sledge-hammered oil drum the flyer's nose slammed to the ground. Carmen shoved on the throttle, but even as she cut the drive the nose flipped up again, overshooting level by a meter or so. For that instant the underside repulsers were aiming slightly forward, giving the flyer a small backward thrust. By the time they'd leveled out once more they were three or four meters from the high-g field, leaving behind a very flat piece of metal to mark the place.

"Nice flying, Miss Olivero," Sadowski said tightly. "I hope whatever we lost there wasn't vital."

"Me, too," Carmen agreed, the first glimmering of real hope stirring in her. The high-g ring was no more than a meter wide—an impassable barrier for a human being, but perhaps not for what she had in mind. Taking a deep breath, she swung the flyer around and backed into the field.

They were moving faster this time, and hit the ground with a correspondingly louder crash. Ignoring the groans and snaps of tortured metal and plastic, Carmen ran the thruster limit all the way up and waited tensely for the automatic leveler to raise the tail off the ground. The usual background rumble rose to a scream, and she felt her hands curling into fists. The repulser units themselves could handle enormous temperatures, but it was doubtful the designers had expected the flyer to be flat on the ground at the time. She envisioned the underside plates buckling with the heat, perhaps melting or even boiling away—

And with a barely perceptible lurch the tail came off the ground.

Carmen was ready. The flyer's nose jets spat at full thrust, pushing the craft backwards. Two meters were all they could manage before the underside temp monitors hit critical and shut down the repulsers, bringing the craft back down with a bone-jarring crunch. But two meters was enough. Flipping to "spacecraft" mode, Carmen shut down all fuel to the main engines, killed the pre-heating ignition system—and the monitors that might otherwise prevent her from doing this—and slammed the throttle to full power.

And with nothing to hinder or react with it, the flyer's compressed oxygen supply began pouring through the main repulser units, spraying directly toward the motionless figures beyond the barrier.

"They're moving!" Sadowski, pressed against the side window, turned back to face her, a wide grin plastered across his face. "They're okay."

Carmen closed her eyes briefly and let out a shuddering breath. Reaching down, she put the throttle back to half and popped the door beside her. "I'm going out for a look. Let me know when the O_2 level hits point three—that screen over there."

Hopping down carefully, she limped around the curve of the flyer, making certain to stay well back of the high-g field. Beyond it, the five men were sitting up now, looking dazed but other-

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wise all right. She started to wave, but even as she raised her arm Hafner suddenly clutched Nichols's shoulder and pointed toward Olympus. Carmen raised her own eyes—and gasped.

Glittering like spun silver in the sunlight, a filament was shooting skyward from the volcano's crater. She was just in time to see the leading end vanish into the blueness above, and for an instant the strand seemed motionless, conjuring the image of Astra hanging from an impossibly thin skyhook. Then the other end of the thread left the volcano, and she realized with a fresh jolt just how fast the thread was moving. Escape velocity for sure; perhaps much more.

She was still standing there, staring upward, when the steady wind blowing in her face abruptly died, nearly toppling her onto her face. Recovering, she looked down at the others. As if on cue they turned back to her as well; and, after a moment of uncertainty, Perez picked up a stone and lobbed it in her direction. It landed at her feet without any detectable deviation, and a minute later they were all standing together by the flyer.

"Are you all right?" she asked, her eyes flicking to each in turn.

"We're fine," Hafner nodded. He had a bemused look on his face, as if wondering whether any of it had really happened. Carmen could sympathize; with gravity back to normal and that mysterious thread long out of sight, she could almost imagine the whole thing had been a dream or mass hallucination.

Until, that is, she got a close look at the flyer's crumpled tail section.

* * *

CHAPTER 10

"The shuttle's matched orbits with the cable now," Captain Stewart reported. "It should be just a few more minutes."

Listening in from a few million kilometers away, Meredith swallowed hard against his frustration. He'd desperately wanted to be on the scene when rendezvous was made, and the fuel-efficiency arguments which had prevented the *Aurora* from stopping first for passengers weren't the least bit comforting. Whatever that cable was, it was an Astran discovery, and he didn't like the feeling that Stewart was cutting them out of things.

Brown, sitting beside Meredith in Martello's communications center, seemed to feel the same way. "We're still not getting the picture you promised," he told Stewart. "You want to get someone on that, Captain?"

"So far, there's nothing to see," Stewart replied. "Even the shuttle's cameras still only show occasional glints. We'll tie you in when they go EVA for the material tests."

"Do that," Meredith said. "In the meantime, have you refined your dimension estimates any?"

"Not really. We still make it about six centimeters in diameter and something over two kilometers long. When we can get a piece of it to work on we'll get density and composition, but I'll bet you the *Aurora* we've got your missing metal right here."

"Yeah. Well, there's just one problem with that." Tapping computer keys, Meredith called up a list of numbers. "Our best estimate right now is that we lost about forty-seven hundred kilograms' worth, including all the stuff in

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the fertilizer. If the cable's the density of iron, say, it shouldn't be more than a tenth that length. So where'd the rest of the mass come from?"

"No idea," Stewart admitted. "Maybe the chemical analysis will give us a clue." He paused. "Okay, they're exiting the lock now. Here we go."

In front of Meredith the screen came to life. To one side of the camera was the bulk of the shuttle, from which a spacesuited man equipped with a maneuvering pack was emerging. On the other side of the picture, the cable was just barely visible. A second figure joined the first, and for several minutes they jockeyed around the cable taking pictures. As Meredith had half-expected, there was no more detail to the cable's surface at close range than had been visible farther out.

"That should be enough," Stewart said at last. "Try the cutters now—stay near the end."

"Roger." The first astro had unclipped a set of what looked to Meredith like a mechanized lobster claw. Moving forward, he set the blades against the cable—and suddenly swore. "Damn! It's *stuck!*"

"What do you mean, stuck?"

"As in glued to the cable, Captain. I barely touched it, and now I can't . . . I can't even get it loose running the motor in reverse."

Meredith exchanged a quick glance with Brown. "Maybe you can still cut it," he suggested into the mike. "Or at least cut enough groove to give us its hardness."

"Yes, sir." A pause. "I'm trying, sir, but nothing's happening."

"That's impossible," Stewart cut in. "I've seen those cutters handle ten-centimeter tungsten plate withou—"

"Look out!" one of the astros shouted, and Meredith flinched in automatic reaction as the men on the screen jerked back.

"You all right?" Stewart asked sharply.

"Yes, sir," the rattled answer came. "We've just lost the cutters. The motor burned out—scattered small bits of itself all over the place. Uh . . . I can't even see a scratch underneath the blades."

For a long moment there was nothing but the hum of the radio's carrier. "I see," Stewart said at last. "Well . . . does the reflectivity read low enough to try using a laser on it?"

"Just a second, sir . . . we could try the UV, I suppose; the reflectivity seems to increase with wavelength. But I'm not at all sure it'll do any better than the cutters did."

"Try it anyway," Meredith instructed. "You can at least get a heat capacity estimate that way."

It took a minute to get the laser ready, and two or three more to position the infrared sensors that would measure the cable's temperature. "Here goes, sir. Laser's going . . . reflection about thirty-eight percent—that seems low for a metal—"

"Temperature's starting up slowly," the second astro put in. "Up to . . . what the *hell?*"

"What?" Stewart snapped.

"The temp just . . . *dropped*, Captain; dropped like a stone all the way down to . . . well, to a few degrees absolute."

"Superconductor," Brown murmured, sounding awed.

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"That's impossible," the astro retorted. "The reading was well above superconductor temperatures when it dropped."

Stewart ordered several more tests run, but each one simply added another mystery to the growing list. A portable wire-tester was hopelessly inadequate for measuring tensile strength—the cable didn't even stretch, let alone break. A standard metal detector gave no reading even a few centimeters away from the cable, but a direct measurement of resistivity showed that, under sufficiently high voltages, the material became a superconductor of electricity. And possibly the oddest discovery of all came when one of the astros accidentally brushed the cable and stuck fast. In attempting to cut him loose, his partner found that the "glue" had somehow penetrated several centimeters *into* the spacesuit fabric, rendering that section nearly as unbreakable as the cable itself. In the end they had to cut a gaping hole around the affected material, leaving the astro to do a decompressed reentry to the shuttle.

"I don't know about you," Meredith told Stewart when the two astros were back inside, "but I'm ready to call it a day. It's obvious we're not going to find out anything more with the equipment you've got out there. I think we're going to have to bring the cable back here."

"As in Astran orbit, you mean?"

"As in groundside."

There was a long pause. "And how, may I ask, do you intend to land two kilometers of heavy cable?" Stewart asked. "Without endangering one of my shuttles, that is?"

Meredith looked at Brown, gestured toward the mike. "We've been studying the problem ever since the cable was discovered," Brown told the captain. "Given the length and stickiness, I think it would be most reasonable to wrap it around itself, pretzel fashion, and tow it into near orbit. Once there, you could put a remote booster and some parachutes on it and send it on down. There are lots of open areas we could drop it in—north of Wright might be good, since a lot of our heavier equipment is up there."

"Out of the question," Stewart said. "We'll tow it back to Astran orbit, but that's where it's going to stay. Bring it down and you'll never see it again under the layer of dirt it'll collect."

"And then you'll run off and report all of this to the Pentagon, right?" Meredith asked.

"In a few days, yes. Why?—were you planning to keep it secret?"

"No. But once you're gone, what's to keep someone else—the Rooshrike, perhaps—from towing the cable back *out* of orbit?"

There was another long silence. "Do they know about the cable?" Stewart asked.

"I haven't the foggiest. You want to take that chance?"

"Damn." Stewart let out an audible breath. "Major Brown, let's hear those numbers you said you'd worked out."

In the end, with a maximum of difficulty and a minimum of actual damage, they brought the cable down.

CHAPTER 11

It was known colloquially as the "silent room" because it was the only place in

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the White House proper that was absolutely guaranteed against all forms of audio, electronic, or laser-scan eavesdropping. Today, President Allerton reflected, it was even more silent than usual. There were none of the normal mutterings or whispered discussions among the assembled advisors, Cabinet officials, and military men; just the soft sounds of pages turning. Generally speaking, their faces made up for the lack of vocal expression.

Allerton gave them plenty of time before clearing his throat. "Well. Comments?"

General Klein got in first with the obvious one. "Unbelievable. Simply unbelievable. Something on Astra *made* this thing?"

National Security Advisor Thomas Morley was staring into space. "I trust you realize, Mr. President, how self-contradictory this report looks. A super-sticky metal that doesn't show up on metal detectors? And stronger than graphite-boron sandwich but only four-fifths as dense as water?"

"I assure you, Mr. Morley," Captain Stewart spoke up quietly, "that I was present while the cable was being tested. I don't understand any of it either, but the numbers *are* accurate."

"Wasn't implying they weren't," Morley said. "I was just anticipating what others are going to say when we release this."

"Why release it at all?" Admiral Hamill rumbled. "It was discovered by American citizens on an American colony—that makes it American property."

"Except that we're technically running it under a UN mandate," Allerton reminded him.

Hamill's snort concisely gave his view on that.

"I think Tom's right, sir," Secretary of State Joshua Purvis spoke up. "We've complained all along that the UN should be footing more of Astra's bill. Someone's bound to accuse us of making up this cable and this—this planet-sized spinneret for the sole purpose of stirring up interest and funding. And so far there doesn't appear to be any way to bring a section of the cable back here to show."

"Why do we have to show them anything?" Hamill persisted. "If you think we have to tell the UN, all right, but if they don't want to believe it that's *their* problem. I hope they don't, in fact, because that'll leave us free to send *our* experts out to study the thing."

On that point, at least, everyone was agreed, and the rest of the meeting was devoted to deciding on the procedure for recruiting the necessary scientists and getting them to Astra as quickly and quietly as possible. Afterwards, Allerton put through scrambled phone calls to the British, Japanese, Soviet, and Chinese heads of state, whose reactions combined fascination and thinly-veiled disbelief in about the proportions Allerton had expected. And lastly, he made a call to UN Secretary-General Saleh.

Saleh was silent for a long moment after Allerton had finished, his face almost expressionless as his eyes probed Allerton's own. "You would not," he said at last, "insult me by creating such a ridiculous lie. What are your thoughts about this—did you call it *Spinneret*?"

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Allerton shrugged. "Nothing I've heard the Ctencri say has even hinted at this type of technology. Particularly the gravity control the Spinneret exhibited—if the Ctencri or anyone else in the area had something like that they ought to at least be using it to launch spaceships."

"You can surely assume the Rooshrike had no inkling it was on Astra, also," Saleh ruminated. "Unless they had tried already to locate it and hoped we could do so for them . . . no. That makes no sense."

"I agree. Almost certainly this is completely unknown, at least in this part of space. And it's going to drastically change mankind's position in the interstellar trading community."

Saleh smiled sardonically. "As well as that of the U.S. in *this* community, of course." The smile faded. "I imagine your mandate will have to be reconsidered."

"I don't see why," Allerton said, keeping his voice steady. He'd known the Astran Mandate would quickly be altered—if not scrapped altogether—but had hoped disbelief in the report would slow the process. "We haven't broken any of the conditions of the agreement."

"Don't act naive. We both understand the politics involved . . . and how those politics have now changed."

"Certainly. But if those nations—and groups of nations—who thought Astra was an amusing albatross to hang around our neck think they can vote themselves a large piece of the pie we've discovered, they'd better check the fine print. The mandate can't be changed without Security Council approval, and last I checked we still had a veto there."

"Legally, of course, you're correct," Saleh conceded. "But I'll warn you that you'll face a great deal of world-wide public condemnation if you attempt to keep Astra's discoveries for yourself."

Allerton leaned back in his chair and favored Saleh with a faint smile. "Actually, Mr. Saleh, I think in a case like this I'd be perfectly willing to tell world opinion to go take a walk in hard vacuum. For once the United States is not going to back down from a perfectly legal *and* reasonable position just because someone else doesn't like it."

Saleh's face was still calm, but there was a glint in his eye. "I understand your feelings, perhaps better than you think. But I warn you against biting off more than you can chew. Remember that all contact with the Ctencri is still by way of the UN, including trade both ways. We have more teeth now than at any time in our history . . . and I know of quite a few nations that would welcome the opportunity to test those teeth."

"Well, you tell them to go ahead and try it," Allerton said. "I think that as of right now we have a few new teeth ourselves. Good-bye, Mr. Saleh; I'll have a copy of this report sent over to you by secure messenger."

He broke the connection. *I probably shouldn't have told him off like that,* he thought, a bit guiltily. Saleh wasn't so bad, even if he *was* spokesman for the biggest unlanced boil in history. But every time a UN vote went down he got a thousand irate letters demanding he do something, and up to now he'd always had to choke down the national pride and pretend he was above such petty politics.

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And he was damned if it hadn't felt good to let it out at last.

Still . . . Activating the phone again, he keyed for the Secretary of State. "Josh, have you gotten anywhere yet with the Ctencri on direct trade?"

"Nowhere at all. They still insist all goods in either direction go through the UN Secretariat. I don't know whether they're pushing for a one-world government or just generally like sticking with their first contact in a new market."

"Whichever it is, we can't let it continue," Allerton told him. "Step up the pressure. I want a trade pipeline that's free of UN control as soon as possible."

"I understand, sir. We'll do our best."

Saleh's office was also classified a silent room, but unlike that at the White House, his had played host on numerous occasions to Ctencri representatives . . . and Ctencri surveillance equipment was on a par with the rest of their technology.

The pulse reader went black, and First Trader Sen sat quietly for the moment it took his mind to process the information from visual short-term memory. Unbelievable. Utterly. An unsuspected alien technology—and on Rooshrike Parkh-3, of all unlikely places. An irony of first magnitude . . . but an equally great opportunity. For once the Ctencri policy of patiently taking new races by the ears and pointing them toward interstellar trade had brought in something more useful than a few paltry *troid*-weights of metals.

Turning to his recorder, the First Trader grunted it on and began outlining his campaign. Other races—the M'zarchs, for obvious example—would, in such a position, probably attempt to gain control of this Spinneret through threats or open violence. The Ctencri weren't incapable of such actions themselves, but experience had shown there were better ways. In this case, it would be a simple matter to inveigle for themselves the position of agent for the Humans, handling the sale and leasing of their new technology for them. Not only would the commissions bring immediate profits, but the simple act of handling all out-system contacts would continue to keep the Humans isolated from the other races and thus increase their dependence on the Ctencri. It was an old, old technique, but surprisingly effective for all that.

So first: all Ctencri contacts and surveillance on Earth would be immediately tightened. The Humans' tangled political system was still murky enough to defy predictive analysis, and pressure might be needed at any of a hundred points on a moment's notice. Second: the home world would be notified. There was a small bit of personal hazard in that, of course—they might decide to replace him with someone else and he would thus lose the chance to see the campaign through to completion. But even if that happened his name and financial position were still secure. The discovery and project initiation were his, and his percentage of the final profits was fixed. If he were replaced and his successor muffed it, he would be paid out of the bungler's personal holdings.

And third: potential buyers had to know the product existed. A notice, sent

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free to each of the other races, describing the cable and perhaps a bit about the Spinneret—curious name!—itself. Not too much of the latter, though. If the metal-leeching and gravity-control aspects of the device weren't exaggerated they represented a truly awesome potential, and it would be best not to tempt any of the more violent races overmuch. The delicate political structure of the trading community was bound to shift somewhat with this discovery; the First Trader had no interest whatsoever in bringing the whole thing crashing down. Wartime trading wasn't nearly as profitable as it was often portrayed.

Dialing up a vial of *semarin*—not really the brain-stimulator it was reputed to be, but a pleasant scent nonetheless—he took several sniffs and began composing the data release.

It was something of a truism among those who knew them that the M'zarchs never talked when they could be taking direct action instead, but even with such a base line the meeting of the High Command was abnormally short.

"No question," the Senior Commander declared. "We attack."

There were grunts of agreement around the tableless room—tableless so that none of the assembled Clan Commanders could secretly draw a weapon. "We will need to penetrate both Rooshrike and Pom territory," one of the others pointed out.

Another hissed depreciatingly. "It will not take a fleet to annex this world. A quarter-wing could bypass Rooshrike detectors with ease."

"The Poms will not be fooled."

"Poms do not engage alien craft unless they perceive a threat to themselves," the Senior Commander said. "Our course through their territory will be open and clear of worlds and bases."

The first speaker covered his eyes briefly with the backs of his hands. "I do not object; I merely caution. The subtleties of alien minds are still new to me."

"Do not grovel," the Senior Commander admonished him sharply. "Coward's Advocate carries rights as well as duties. No one may challenge you for what you say—but you must not then leave that role."

A startled expression passed over the other's face, replaced quickly by dismay, and the Senior Commander permitted himself a moment of satisfied amusement. Coward's Advocate was always the hardest Command position to fill, but it was usually possible to trap newcomers into it in precisely the way he had just done. By the time the new Coward's Advocate had built his clan's power to the point where he could withstand any challenges his role might retroactively bring him, there was bound to be someone else the duty could be maneuvered onto.

The moment passed, and it was back to business. "You and you," he said, gesturing to the two most powerful Clan Commanders. "One warship each. You—" he indicated a third—"a heavy troop carrier. Each clan to provide a company/minor. Rendezvous at Kylisz Outposts in ten days; assault launch in eleven. Question?" He looked at the new Coward's Advocate, but the latter remained silent. "Then we are dismissed."

* * *

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CHAPTER 12

Dr. Simon Chang had a round face, an almost equally round body, and a naturally sunny countenance that had somehow managed to survive the boring three-week trip from Earth. He didn't look much like a materials scientist—at least not to Meredith—but the way he gazed at the Gordian knot tangle of cable spoke louder than even the credentials he'd brought with him. "Magnificent!" was his first comment.

Meredith had to agree. Though much of the cable had acquired a heavy layer of dust, a six-meter length near one end had wound up in a nearly vertical position, its own weight having since bent it into a shiny quarter-circle. At the very tip were the remnants of the cords that had once connected to a reentry parachute; arrayed along the length were various clamps and sensors, all held solidly in place by the cable's own glue. "I hope you and your people can hold onto that enthusiasm," he told Chang. "The cable is proving a *very* tough nut to crack."

"I don't doubt it." Chang tore his eyes away long enough to glance around the warehouse-sized shelter that had been erected around the landing site. "But we've brought a good deal of specialized equipment with us. What have you learned so far?"

Meredith beckoned to a harried-looking officer. "Captain Witzany, Corps of Engineers," the colonel introduced him. "His people are the closest thing to materials specialists we have. Captain, tell Dr. Chang what you've got."

"Very little, I'm afraid." Witzany gestured to something that looked like a giant vise. "We know now that its tensile strength beats that of a graphite-epoxy bar by at least a factor of three, but that was the limit of our jury-rig. The glue—or whatever—doesn't seem to bond appreciably to liquids or gasses, but it really *does* extend a few centimeters into any solid material that contacts it."

"Does the effect begin before contact is made?"

"No, sir. It's not like a magnet starting to attract iron, if that's what you mean."

Chang nodded thoughtfully. "Have you learned anything more about its electrical properties? The preliminary report was rather self-contradictory."

"That's the cable's fault, not ours," Witzany replied. "It's a very all-or-nothing sort of material: either insulates or superconducts, but nothing in between. Based on that, we're guessing that if we ever *do* break it, it'll snap without stretching first."

"*When* we break it," Chang corrected mildly. "Have you done any tests on the emission spectrum when you heat it? I know it becomes superconducting, but the heat has to come out *somewhere*."

"We did that, sir—it took three days of continuous heating to get it hot enough, but we managed it. The spectrum centers mainly in the red and infrared, of course."

"That should be good enough." Chang looked at Meredith. "From that we should be able to get some idea as to its composition."

"I wish you luck, Doctor," Meredith said. "I don't believe Captain Witzany's team has been able to match up

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any significant section of the spectrum with known elements or compounds."

Chang waved that aside. "I think my library will be adequate to the task. I'd like two clear copies of the spectrum and some computer time as soon as possible."

Something sour flickered for a moment in Witzany's eyes. "Yes, sir," he said. "I'll be happy to give you any assistance you need—"

"Won't be necessary, thanks," Chang told him. "My staff and I can handle things from now on. Just give us all the data you've got and then you'll be free to return to your other duties."

This time the look in Witzany's eyes lasted long enough for Meredith to identify it. After sweating over the cable for a month and a half it was suddenly and casually being taken away from him, and he didn't like that at all.

Neither, Meredith suddenly realized, did he. Astra was finally getting the official attention it deserved—but in a way, it served mainly to remind him of the lukewarm support they'd been given up until now.

Witzany nodded toward Meredith. "Colonel Meredith has classified all our reports. I'll need his written authorization before I can turn them over to you."

"Don't be absurd, Captain—I have both Congressional and Joint Chiefs clearance to examine anything on Astra I want to."

"Of course, Doctor," Meredith interjected. "It's just a formality, but a necessary one. It'll just take a few minutes."

"Colonel—"

Meredith cut off Chang's protest with an upraised hand as his phone buzzed. "Excuse me," he said, and answered it.

It was Major Brown at Martello. "Colonel, we've got a Rooshrike spacecraft approaching. Says he's Beaeki nul Dies na—the one who visited right after we arrived—and that he wants to land and talk with you."

Meredith felt his eyes narrowing. "About what?"

"I don't know. But he's being *very* polite."

Meredith focused on Chang. "Can you put me through to the *Pathfinder* on a tight beam? I want Captain Radford."

"Just a minute, sir."

Chang took a step toward Meredith. "Is anything wrong?"

"I don't know yet," the Colonel told him shortly.

There was a crackle and Radford's voice came from the phone. "Radford here. What's up, Colonel?"

"Had anyone on Earth leaked news of our cable before you left?" Meredith asked. "Specifically, had they leaked it to the Ctenori or the other aliens?"

"As far as I know, it was still a dead-dark secret," Radford said slowly. "Why would you think . . . the Rooshrike ship?"

"Yeah. I find the timing highly suspicious, given they've been ignoring Astra entirely for the past three months."

There was a short silence. "I thought the idea of bringing the cable down there was to keep anyone from trying to filch it."

"It was." Meredith let his breath out in a hiss, tapped a button on his phone. "Brown?"

"Yes, Colonel?"

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"I want you to patch me through to the Rooshrike. You and Captain Radford are to listen in and make recordings of the conversation. Got it?"

"Yes, sir."

"Give me a second to set up the tamper-proof recorder," Radford added.

Meredith was suddenly aware that all activity and conversation in the cable shelter had ceased. Chang was looking slightly befuddled, but Witzany and his assistants had nothing of uncertainty in their expressions. They knew something was up.

The phone beeped. "You're through, Colonel; go ahead," Brown told him.

Meredith brought the phone a bit closer to his mouth. "This is Colonel Lloyd Meredith. I'd like to speak to Beaeki nul Dies na."

"I am Beaeki nul Dies na," the response came immediately. "I speak for my people."

"Uh, yes—I also speak for my people. I'd like to know the purpose of your visit."

"I wish to discuss trade with you."

"I see. Trade for our sulfur, I presume?"

"You need not seek to deceive," Beaeki said. "I offer you free information as a sign of sincerity: we know of the advanced technology which you have discovered and of the cable it has produced. We wish to purchase a length of the cable for examination; depending upon its properties we may be interested in trading for usable quantities of it."

Meredith stared at the phone for two heartbeats, his thoughts racing. "How did you find out about the cable?" he asked, more to gain time than anything else.

"We obtained the information from the Ctencri, who intend to act as agents for Earth in future sales. My people feel a more mutually equitable arrangement may be possible by trading directly with you."

"I see." So Earth had made a deal with the Ctencri without even bothering to tell him . . . or had the Ctencri set up the whole thing unilaterally? Or, for that matter, were the Rooshrike making the Ctencri connection up in hopes of pushing Astra into a hasty and ill-considered contract? Meredith hesitated, knowing that to appear indecisive might be the worst thing he could do, and wishing like hell he had a little more information. "As far as selling you a piece of the cable, I'm afraid I cannot permit that at present. However, we *will* sell you the data we have collected, either now or in a few days when our new test equipment has been set up."

Beaeki's answer might have helped Meredith figure out what was going on, but as it happened, the Rooshrike was never given time to reply. "Colonel; we're picking up another ship," Brown cut into the conversation, his voice tense. "Just shifted into the system—we caught the flash. About one point four million kilometers and coming toward Astra."

"Colonel, we just picked up a second flash," Radford announced. "—Make that a second *and* third."

"Confirmed," Brown said.

"Are those yours, Beaeki?" Meredith asked sharply.

"No," the alien replied. "It is possibly a trade delegation from another people—"

"I doubt that seriously," Radford cut

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him off. "Trade delegations aren't likely to arrive in flanking maneuvers."

Flanking maneuvers. Uh-oh. "If those aren't yours I suggest you get out of here fast," Meredith said.

The Rooshrike didn't answer, but suddenly the phone erupted with a low whistle. "There he goes," Radform reported. "Like a bat with afterburners . . . there—he's shifted. Intruders still coming."

"Major? Try to raise them."

"Right." There was a long pause. "No answer. Either they ignore all the supposedly standard frequencies or else they haven't got a translator that handles English. Or they don't want to talk."

"I don't think there's any real doubt as to which it is," Meredith said quietly. "I think we'd better prepare for an invasion."

"Agreed," Radford said, his voice icily calm. "The *Pathfinder*'s at your disposal, Colonel."

"Thanks, but I don't know what you can possibly do except get yourselves blown out of the sky. I suggest you pull back—*way* back—and wait to see what happens. If they threaten you directly, you'd better run for it."

"Unfortunately, I agree. All right. Pulling back now and going to communications silence. Good luck to you."

"Thanks. Brown?"

"Sir?"

"Red alert, all units. You might as well make it a general announcement; the civilians are in this with the rest of us and might as well have as much time as possible to prepare."

"Yes, sir. Announcement going to all centers now. Deployment orders?"

Meredith paused for thought, and as he did so noticed for the first time that the others in the room had quietly gathered into a semicircle behind Witzany and Chang. To a man, they all wore the same expression: scared and edgy, but with a spring-steel resolve beneath it all. He'd seen that expression only once before, on Egyptian villagers preparing to defend their village aginst the Libyan war machine rolling toward it. It was a shock; he hadn't realized that in just three months his men could start thinking of Astra as home.

Or, for that matter, that he himself could.

"Squad-level dispersal," he told Brown. "It doesn't make any sense to try and hold Martello or the admin buildings. We'll split into guerrilla-size groups and try hit-and-run tactics once whoever-they-are have landed."

"Not much cover for that."

"I know, but if we stand and fight they can wipe us out from the sky. As many men as possible should head for the Kaf Mountains or the hills near Teardrop Lake. Someone should take the flyers into the Kafs, too."

"What about the cable, Colonel?" Witzany asked.

"Leave it," Meredith said. "If that's all they want, they can take it and go."

"What?" Chang exploded. "Colonel, that cable is priceless—"

"What's priceless is the machinery that made it," Meredith cut him off. "And I'm betting that's what they're really after."

"Colonel," Brown spoke up. "Orders are out, but we've got a glitch re the flyers—one of them is at Olympus with Hafner's group."

"Damn." Hafner's daily attempts to

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locate the cable-making machinery had become so routine that Meredith had clean forgotten them. "Better have them stay put."

"Right. Flyer One is heading for the mountains now."

Meredith mentally crossed his fingers—Flyer One hadn't been up since limping back to base from its encounter with that high-g field—and then put the matter out of his mind. Valuable as the flyer was, it held just two lives in its grip—two out of the nearly ten thousand Meredith was responsible for. "All right. I'm heading back to Unie; I'll pick up coordination from you when I get there."

He had just passed Wright and hit real road once again when the inevitable ultimatum came. "They won't identify themselves," Brown relayed tensely, "but they order us to halt all aircraft and ground vehicles and to assemble outside our buildings."

"Any 'or else' come with that?"

"Not explicitly, but it seems pretty self-evident."

"Yeah. How's the evacuation going?"

"Slowly. The civilians just aren't moving fast enough."

Meredith swore under his breath. "Are the invaders close enough to spot car traffic yet?"

"Depends mainly on whether they know where to look, I'd say. One of the ships is already below geosync; the others are hanging back. So far they're ignoring the *Pathfinder*."

"Um. All right. Tell the aliens that until we have their identity and full intentions your commander refuses to knuckle under. Use as much slang as you can—out-of-date slang, if you know any. That plus having to run their messgages through you may buy us a little more time."

"Right. Even so, I don't think we'll be able to get everyone out of the towns. Permission to set up defensive positions?"

"I suppose we'd better. The admin buildings are probably your best bet—you can use fertilizer sacks in lieu of sandbags."

"Already thought of that. Do you want to set up deployment now or wait until you're back in Unie with secure lines?"

Meredith hesitated. He very much wanted to handle that personally, but he had few illusions as to how long they could stall the enemy. "You'd better do that yourself," he told Brown. "Give the local commanders autonomy, consistent with the goal of defensive holding action. Use the computer net as much as possible—they'll at least have to work hard to tap into that."

"Yes, sir. I'll funnel the final plans through to your office; I think we can keep them confused up there until then."

Meredith wasn't at all convinced of that, but whether through confusion or a simple desire to take a good, long look at the landscape, the invaders *did* hold off long enough for the colonel to reach Unie. He was in his office, skimming through Andrews's hastily prepared defensive setup, when Brown informed him that the close-orbiting ship had launched two craft. Bare minutes later a low rumble became audible, growing quickly to a sonic-boom crash as one of the craft shot directly overhead, heading east. Through his window, Meredith watched it brake to a midair halt on its

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repulsers and settle to the ground somewhere between Unie and Crosse. He tensed, waiting for the sound of gunfire . . . but for the moment, at least, there was just a watchful silence.

So here we go, Meredith thought, reseating himself at his desk. *The Battle for Astra has begun. I wonder what our chances are?*

But that line of thought was unprofitable. Flipping on his phone, he began checking to see which of his communications lines were still open.

CHAPTER 13

"They're rolling out some kind of flyers now—bigger than ours," Hafner announced, adjusting the focus on his binoculars a bit. "Looks like they've got four of them. The rest of the troops are still fanning out toward Crosse and Unie."

Standing beside him, Carmen shaded her eyes with one hand as she peered off to the west; the other hand, pressed to her side, was clenched into a fist. Two-thirds of the way up Olympus's south face, Hafner's expedition had found themselves in a grandstand seat for the alien ships' landing—but for Carmen, at least, the ability to see but not to help was an almost suffocating combination. *I should be down there,* she thought over and over. *I should be helping run tactical programming. I take off* one day *to run Peter up here and the whole world falls apart.*

"Shouldn't we call and warn them about the flyers?" she asked Hafner.

Binoculars still at his eyes, he shook his head. "I'm sure both Colonel Meredith and Major Barner have scouts within sight of that ship. No, if we radio anything now we'll just advertise our presence here. I'd rather save that for something really important."

"But we can't just sit here twiddling our thumbs," one of the others objected. "Isn't there something we can do with *our* flyer? A bombing run, evacuation—anything?"

"If you can whip together some bombs out of moissanite rock, be my guest," Hafner said tartly. "And as for evacuation, you wouldn't get half a kilometer before you'd have all four of those things on your back. . . ."

He trailed off. "An idea?" Carmen asked.

"Maybe." He lowered the glasses and frowned off toward the south. "Do you remember the spot where the other flyer crashed, our first day here?"

"Flyer Two? Um . . . I've got a rough idea."

"They never did find an actual cause for it, did they?"

"Not that I know of. Why?"

"Well," he said slowly, "we know now that this mountain has some incredible collection of machinery underneath it. Could it be that the fields in the flyer's repulsers triggered a—oh, I don't know; a resonance or feedback type of reaction in something underground?"

She thought about that a long moment. "I suppose it's *possible,*" she conceded. "But I don't know what good that would do us. Besides, it seems to me we've flown over that spot ourselves, so whatever happened must have been a one-shot event."

Hafner was still gazing south. "Perhaps . . ." Abruptly, he took a deep breath and turned back to the west. "At any rate, that gives us an idea of the

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scale involved here. The aliens won't be able to just pack everything up in a suitcase and take off with it."

"Uh-huh." *But that's not what he was thinking,* she told herself, studying his profile suspiciously. *He's got something else in mind. What?*

But for the moment, at least, he didn't seem inclined to talk about it. Swallowing her curiosity, Carmen turned her thoughts back to the drama unfolding to the west, wishing she were there.

Meredith had rather hoped the alien commander would use the communicator's vision attachment, but wasn't overly surprised when the screen remained blank. Though off-planet radio was being thoroughly jammed he'd seen enough of the aliens to know they prefered to err on the side of caution. Of course, concealing their identity could also mean they were planning to keep their victims alive. It was a thought worth holding.

"I'm sorry, Commander," he said, for the fourth time in half that many minutes, "but many of my people do not carry personal phones. I simply cannot whisk them back to their digs on a second's notice." A note from Major Gregory in Wright appeared across his computer screen: the second landing craft had set down in the fields just east of Wright and was disgorging space-suited troops at an alarming rate. Preliminary estimates—

The alien's reply cut into his reading. "You seek to slow me with dialect variants, but such tactics are pointless. I do not intend to harm your people unless absolutely necessary. I similarly do not intend to allow them free movement. If necessary I can use infrared and composition sensors from low orbit to locate them individually. You have one planetary rotation to return them to their towns. After that they will be considered as challengers to my rule and dealt with accordingly."

Meredith's throat felt very dry as he swallowed. He had no idea how accurate the aliens' sensors actually were, but he doubted any of his troops could burrow underground deep enough in twenty-seven hours to escape them. *I should have started building defenses as soon as we realized the size of what we had here,* he berated himself dully. *But, damn it all, this trading association is supposed to be politically stable.*

"Commander, I await your decision," the alien said.

"Yes. Uh . . . what guarantees do you offer for the safety of my people?"

The other began to speak . . . but Meredith never heard the answer. A short message from Major Barner appeared on his screen, grabbing his full attention:

FORWARD SPOTTERS REPORT ALIEN LANDING CRAFT RESTING ON METAL REPEAT METAL LANDING SKIDS:

Meredith stared at the screen, his mind racing. Barner's implied suggestion was obvious . . . but how did the major expect Meredith to put it into effect? No one knew how the thing had been triggered the first time, and there was certainly no time to experiment now. He would have to gamble, and hope Astra was on their side for once.

The alien stopped talking and Meredith licked his lips. "Very well," he said. "If you will lift your jamming, I'll

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broadcast instructions to as many of my people as I can."

"The jamming has ceased."

With fingers that trembled only slightly, Meredith keyed in all the broadcast channels available, not forgetting the phone systems. "This is Colonel Meredith," he announced. "To avoid unnecessary killing, I'm ordering all units to surrender to our unexpected guests. As a gesture of good faith, all fertilizer bags being used for shelter are to be *immediately* slit open and their contents dumped onto the ground. Repeat, all fertilizer to be dumped onto the ground immediately."

"You did not give instructions for assembling in towns," the alien said as Meredith shut down the transmitters.

"That'll keep," the colonel told him. Surely they couldn't know *too* much about humans. "When we undertake an act of good faith, we are duty-bound to complete it before other activities may be started."

He waited tensely, but the alien remained silent. *Nothing to do now but wait,* he told himself, wiping ineffectually at the perspiration on his face. *If it doesn't work we'll have to surrender. If it does . . . they'll probably start shooting.*

"You heard the order, soldier." Major Barner nodded to the bewildered sergeant at his command-post barricade. "Start slicing. And be sure and spread the fertilizer evenly over the ground."

"Yes, sir." The man still didn't look happy, but the order he barked to his squad was forceful enough. Holstering their pistols, they produced trench knives and got to work on the thick plastic.

Raising his binoculars, Barner focused on the top of the alien lander, all he could see of it with Crosse's buildings in the way. If this worked, it should start at any time. . . .

It took Carmen nearly a minute of straining before the intervening kilometers of air calmed enough for her to glimpse the underside of the distant landing craft, but once she had seen it she had no doubts left. "Landing skids," she told Al Nichols, who had moved up beside her. "No rubber wheels. Almost certainly bare steel or something equally vulnerable." Lowering the glasses, she offered them to him.

"So *that's* what the fertilizer business is all about." Nichols hung the binoculars around his neck. "Meredith thinks extra metal on the ground will trigger the leech effect. Should work."

"*If* metal concentration is what causes it to start up," Carmen reminded him. She glanced around the mountainside, eyes flicking over the expedition members huddling together as they gazed westward.

Hafner was missing.

She thought about it for a moment as she double-checked the group, but there really was only one place he could reasonably be. Leaving Nichols, she headed downslope toward their flyer.

Hafner was in the pilot's seat when she arrived, forehead corrugated with concentration as he studied the controls. "Going somewhere?" she asked, sitting down beside him.

He glanced up, then returned to his study. "Be a friend, Carmen, and show me how to start this thing up," he said. "Then get out of here."

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For a moment she stared at his profile. Then, deliberately, she reached over and flipped the switch that transferred control to her half of the board. "Where are we going?" she asked, snapping her flying harness around her.

"You can't come," he growled, trying to reach past her to the switch. "I'm serious, Carmen; this is too risky. Give me back the controls and disappear."

"Tell me what you're planning first."

"Oh, for—" He ran his right hand through his hair. "Look, it's obvious what Colonel Meredith is trying, but I don't think the fertilizer alone will do the trick. We've got to get more metal into the ground as fast as possible."

Her stomach knotted. "You're going to crash the flyer?"

"Are you crazy?" He was aghast. "I'm not *that* desperate. I'm going to try and get the aliens to crash one of *theirs*."

"Oh. Well, that's different. For that you'll need a decent pilot." Flipping the ignition, she fired the underside repulsers, their low roar not quite covering Hafner's yelp. "No argument!" she shouted as the flyer lifted. "Colonel Meredith can give me orders, Peter, but you can't. Besides, you know perfectly well I'm right. Now, where to?"

There was a short pause, but when he spoke the argument was gone from his voice. "North and maybe a little east. I want to draw one of those flyers the aliens unloaded and make him chase us."

Carmen nodded and cut in the main engines. Olympus dropped away behind them and she took a moment to check the radar screen. "You have some way in mind to keep them chasing and not shooting?"

"I hope so. But I'm not sure." He hesitated. "That's one reason I wanted to go alone."

Carmen nodded grimly, swallowing all the obvious comments. "Well, get your plan in gear . . . because here they come."

Hafner turned to look out his window. Carmen was on the wrong side to see, but the radar screen told her everything she needed to know. Two of the aliens' four flyers were coming in fast, one at reasonably high altitude, the other almost skimming the ground. Turning back, Hafner slipped on his radio headset. "Is this thing on?" he asked.

She hit the right switch and one-handedly got her own headset on.

"—immediately," a flat translator voice greeted her. "Repeat: the unauthorized Ctencri flyer is to land immediately."

"If you have any interest in the cable we've discovered, you'd better not bother us," Hafner said, his voice betraying none of the uncertainties of a minute ago. "We have in our possession delicate equipment vital to the operation of the machinery. So just pull back and let us go our way." Without waiting for a reply, he reached over and shut off the transmitter. "All right," he said to Carmen, "double back and head southwest toward the spot where Flyer Two crashed."

"Mind letting me in on the secret?" she asked as she put the craft into a tight turn.

"No secret, just a hunch. As you pointed out earlier we've flown over that area several times before . . . but Flyer

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Two was heading due *south* when it failed, and I'm pretty sure we've never passed by going anywhere near that direction."

Carmen thought it over for a long minute. It wasn't impossible, she realized; something like a long underground solenoid or antenna could conceivably provide that kind of directional dependence. But it could just as easily have been a one-shot event. "I hope you're right," she said aloud, wishing she'd known all this when there was still a chance of talking him out of it. "So what do you want me to do, run an S-curve over the region and assume our pursuers will follow a straight north-south path?"

"Exactly. I'm hoping they'll be smart enough to realize that if they just stay with us we'll eventually run out of fuel and have to land. That may keep their trigger fingers steady long enough —*yipe!*"

Carmen twitched violently, the flyer's automatic systems smoothing out the effect on their motion. Bare meters away, flanking them on both sides, the alien flyers had suddenly appeared. Close up, she realized for the first time just how big they really were.

"Carmen!" Hafner's cry was half agonized expletive, half bewildered question.

"I don't *know*," she shook her head, feeling her own nerve sliding away. "Twenty seconds ago they were fifteen kilometers away—I never even saw them move." She broke off, forcing her mind back to the task at hand. *For all their superior equipment,* she told herself firmly, *we know something they don't.* But how to use that knowledge, now that their opponents would be matching their every move?

She thought of a way. Maybe.

"Take a deep breath, Peter," she ordered, "and brace yourself. Here goes nothing."

Ahead, Olympus was sweeping toward them like an inverted tornado. Pulling back on the stick, Carmen shoved the throttle to full power, sending the flyer arching toward the clouds. The alien craft matched the maneuver without the slightest trouble that she could detect; matched it again when she turned the flyer to point due south. Olympus's cone flashed past, far beneath and to her right. Somewhere along here Flyer Two had lost all power—

Gritting her teeth, she shut down the repulsers.

The sudden silence seemed to roar in her ears. She spared a quick glance to the side, found Hafner tight-lipped but with the look of understanding in his eyes. Giving her full attention to flaps and elevons, she tried to remember every scrap she'd ever learned about gliding. The review, unfortunately, didn't take long.

"Any idea what our range is like this?" Hafner asked, his voice studiously casual.

"None." She tried to match his tone, but her performance wasn't nearly as good as his. "We were still climbing when I cut power and we're just leveling out now. It all depends on the glide characteristics of this thing, and I have no idea what those are. I think we'll be past the crash site before we have to restart the engines, but I don't know how much farther than that we'll get."

Hafner turned and gazed out the win-

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dow: "Staying right with us, aren't they? I wonder how we'll be able to tell if—hey! He's dropping below us a bit."

Carmen shot a glance out her side. "This one, too." Could it have happened already? Without so much as a flash of light or crackle of radio static to mark the event? "Hang on," she told Hafner. "We're going to gamble."

Pulling back on the stick, she brought the flyer's nose up sharply, killing their forward momentum in a standard stall maneuver. If the aliens still had power they would have no trouble staying with her . . . and with most of their speed gone she would have no choice but to give up and abort the whole plan—

"They're still going down!" Hafner called, his fist slamming excitedly onto the edge of the control board. "They're gliding, too. *We did it!*"

Carmen's reply was a long exhalation of breath she hadn't realized she was holding. Pulling out of the stall, she sent them into a lazy starboard turn. Only when they were heading west did she risk starting the engines again. They caught at once, and as she started them back toward Olympus she flipped on the radio once more. "Attention, invaders," she said. "Your aircraft, which we ordered to back off, have been dealt with. If you value your lives you will leave Astra immediately." Switching off, she gave Hafner a tight smile. "If nothing else, that should confuse them."

But Hafner was still staring out the window. "Carmen, can you take us back toward where the aliens just went down? I'm not sure, but I think it's started."

It had indeed started.

Unnoticeably at first, of course. Aboard the huge M'zarch landing craft the only indication was a slight vibration, unexplained but not especially worrisome; the troops outside, their attention turned outward, never noticed as the skids melted silently into the ground. The giant ships sank down to rest on their bellies and continued further . . . and by the time the *hull-breach* alarms began their clanging it was too late. The underside repulsers, already being eaten away, could not be fired.

For many aboard the ships it was too late in another sense, as well. Trapped inside their attack-resistant rooms, their minds and reflexes slowed by shock, they found themselves inexorably crushed to death as ceilings were brought down by disintegrating walls and combat armor dissolved into the sandy ground like spun sugar in water. And since these were precisely the people who were considered too valuable to risk outside, the ground troops suddenly found themselves on their own, without senior officers, tacticians, or clan liaisons . . . or heavy weapon support, inter-squad and long-range communications, or defensive sensor cover.

"We have destroyed your landing craft," the Human commander's flat voice came from the translator at the High Command's Chosen's elbow. "You will order your troops to abandon their weapons and surrender or they will likewise be destroyed."

The Chosen's fingers twitched with reaction. It was *impossible*—M'zarch armored landers couldn't be neutralized so quickly by anything short of nuclear weapons. But neutralized they had been, and the troop carrier's own sensors had

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picked up no sign of a nuclear blast. Had the alien Spinneret technology included weaponry? If so, it was more vital than ever that the M'zarch people gain control of this world.

The S'tarm Clan Liaison behind him might have been listening to his soul. "You must not let such technology exist outside M'zarch possession," he said.

The Chosen controlled his temper. "I am listening for suggestions as to strategy," he said, directing his words to all the clan liaisons and High Command officers on the bridge. "I have one-way communication with my ground troops; I can order them to attack and even direct their actions, though at low efficiency. But it is not reasonable to assume the Humans will not use their weapon against the troops if an attack is ordered."

"It is the purpose of troops to give their lives to advance M'zarch holdings—" someone began.

"It is *not* their use to be wasted for no purpose," the Chosen shot back. "Or do you believe their armor can withstand this weapon long enough to accomplish any practical objective?"

"You hold yet one landing craft in reserve," the Chief Tactician murmured, thinking aloud as tacticians were supposed to. "But without more information you cannot expect to add effective counter-measures to its equipment. It is also impossible to predict the weapon's range."

It took most of the clan liaisons a moment to catch the full implications of that. "Impossible!" the S'tarm snorted. "Surely this ship is beyond danger; and if not, the warships certainly are. We still hold the threat of total annihilation over the Humans."

Again the Chosen held his tongue. If the S'tarm continued such stupid comments one of the Command officers would eventually challenge the fool and save him the trouble. One *never* made threats one was unwilling to carry out, and wanton destruction of such a prize as this would draw the perpetrator death for both himself and his entire clan.

"Threats of destruction against the planet are useless," the Chief Tactician said, dismissing the S'tarm's suggestion with a gesture that was just short enough of contempt to avoid drawing a challenge. "However, you may be able to realistically make such threats against their spacecraft."

The words were barely out of his mouth when the three-tone alert twitter rendered them moot. "Chosen," the Defense Officer called over the alarm, "we've picked up the shift-mark of six vessels, on intercept vectors. By configuration . . . Rooshrike corvet-class warships."

The Chosen made an acknowledging sign, the sound of crumpling status loud in his soul. To have failed in such a task would topple him back to the low echelons from which he had so laboriously risen . . . but to have failed *and* to have thrown away lives for nothing would be worse. His own two warships could easily handle six corvets, but that would be only the leading edge of the wave, and he had neither the ability nor the desire to challenge the entire Rooshrike military. "Steersman," he called to the pilot, "raise us to geosync orbit. Speaker: inform the Humans my ground forces will surrender if they will then be per-

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mitted to leave the planet. Broadcast like instructions on the troops' local frequency. Then order my warships to stand ready to submit to the approaching Rooshrike force."

"You are surrendering?"

The Chosen turned back to face the S'tarm. "Yes," he ground out between clenched teeth. "You object?"

"Yes! The glory of the M'zarch people—"

It wasn't precisely a formal challenge, but the Chosen was fairly certain the S'tarm got the point sometime before he carommed off the far bulkhead, his chest already bruising from the blow. The Chosen waited, hands ready for combat, but the other—perhaps recognizing that zero-g fighting was too far outside his experience—slunk off the bridge instead. *At least*, the Chosen thought, *I won't have* him *under my eyelids for the return trip*.

Of course, upon their return he would no longer be the Chosen, either. Perhaps then the S'tarm would take vengeance.

It didn't matter that much. For the Chosen, life as he knew it was already over.

CHAPTER 14

It wasn't until nearly sundown the next day that the observers Meredith had stationed at the foot of Mt. Olympus reported the gravity beginning its high/low divergence; and the ocean was cutting almost dead center across the sun as the new cable was catapulted from the volcano's cone.

"First sunrise, now sunset," Hafner nodded as Andrews relayed the news to Meredith. "Must be designed to fire the cable into Astra's own orbit, more or less. Probably makes pickup a lot easier, especially if a bunch of them drift into the Lagrange points."

"Um," Meredith nodded. "Though at this point I'd say pickup was already the simplest part of the whole operation."

Hafner gave him a wry smile. "Or in other words, our progress out at Olympus has been less than remarkable."

"Still no sign of an entrance?"

"None. However the crater opens up to let the cable out; it doesn't seem designed to let people in."

"Maybe you're just overlooking it." Meredith shrugged. "Three hundred square meters of cone floor plus a hundred more of interior wall around it is a pretty good-sized area to hide a secret entrance."

"Except that I don't think it was designed to be especially *hidden*, and service doors usually are set up to be at least visible."

"What do you mean, 'not hidden'?" Andrews spoke up. "It's disguised to look like a volcano, isn't it?"

"I'm starting to think the form is accidental," Hafner replied. "The short piece of cylinder inside the cone is relatively smooth—made of something like the cable material, I think, minus the stickum—and the outer surface really doesn't look like igneous rock. The more I think about it, the more I'm convinced that the Spinners—"

"Spinners?" Meredith frowned.

"Oh, that's the hypothetical race that built the whole thing," Hafner explained, looking a bit sheepish. "Dr. Chang's team calls the apparatus the Spinneret, you know, and the other just

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came naturally. Anyway, I'm convinced the Spinners just piled up the stuff they'd dug out in making their underground factory, and that heat from the central shaft gradually fused the loose stone into its present form."

"Yes—this underground work area," Meredith said, finally getting to the topic he'd called Hafner in to discuss in the first place. "In the report you and Miss Olivero filed this morning you state that you'd like permission to search the area around the Dead Sea for the entrance. Isn't that going just a bit far afield? We're talking some ten kilometers, *minimum*, between the Sea and the volcano cone."

Hafner shrugged. "The spot where the M'zarch flyers lost their repulsers was nearly that far from the cone."

"But at least a kilometer west of the Sea."

"True. But unless the Spinners went to the trouble to put in a stage elevator in the middle of nowhere, the only convenient place to put an entrance is among the hills bordering the Sea."

Across the desk, Andrews held his phone up and murmured something. Eyes and half his attention on his aide, Meredith said, "You have to understand, Doctor, that while I appreciate the need to learn more about this, ah, Spinneret, I also don't have the resources to spare for the kind of long, drawn-out search you're requesting. We've again lost every bit of metal fertilization and are going to have to either harvest everything prematurely or lay down more fertilizer. The latter would have to be done immediately and mostly by hand—" He broke off as Andrews looked back up. "Well?"

"Colonel, the *Pathfinder* reports two Rooshrike ships have left orbit and are moving to intercept the cable."

Meredith nodded slowly, thinking. It was immediately obvious that he could either like it or lump it, that the chances of the *Pathfinder*'s interfering with the Rooshrike retrieval were essentially zero. Anyway, with the departure of M'zarch ground troops still underway, it wouldn't be a good time to antagonize the cavalry who'd come to Astra's rescue. "Have Radford inform the Rooshrike that we're giving them the cable in return for their timely help and all that—he can figure out how to phrase it."

"Yes, sir."

Meredith turned back to Hafner, half expecting an argument. But the scientist nodded agreement. "Good idea. They'll see through it, of course, but it shows them we understand politics. Incidentally, did the first cable disappear when the leecher went on?"

"No, it didn't seem to be bothered."

"Um. Well. . . . Am I to take it, then, that I'm not getting any more men to help with my search?"

Meredith spread his hands. "We've got to do something about those crops immediately, as I said. After that's taken care of we're going to be building some giant plastic-lined window-box contraptions to see if those could be a possible long-term defense against the leecher. And all of that's on top of all our other work. I can assign you a car and a *reasonable* amount of digging gear, but that's all. You can take it or leave it."

Hafner shrugged. "I'll take it, of course. But I have to say, Colonel, that

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you seem pretty indifferent toward what is clearly an incredibly valuable find."

"Then you haven't been paying attention," Meredith said, some of his annoyance creeping into his voice. "If I didn't care about it you and your fellow scientists would have spent the last two months working in fields or on construction crews instead of poking around Olympus. I'm not stupid, Doctor; I understand what we've got here. But the survival of the people comes *first*. The *Aurora* will be here in a week or two, and Radford said it should be bringing all the extra supplies we asked for. If he's right—if the Hill's penny pinchers haven't cut out half of it—then things *may* loosen up a bit. But I'll believe it when I see it."

"I understand." Hafner got to his feet. "It occurs to me, though, that the problem with the crops might be most simply handled by finding the Spinneret's controls and turning the leecher *off*."

With that he left. Sighing, Meredith looked at Andrews. "I could get very sick of having scientists under my command," he told the other, shaking his head. "Every one of them suffers from tunnel vision."

Andrews shrugged. "Actually, that last didn't seem like such a bad idea to me, sir. Assuming we'd be able to turn the leecher back on again if we wanted to, of course."

"Which is by no means guaranteed. But even if we find something as dead simple as an on-off switch. . . ." Meredith grimaced. "No telling what kind of ground-monitoring equipment the Rooshrike have up there. Or the M'zarch, for that matter—and we don't *know* they'll be leaving as soon as their troops are all aboard."

"And you think that when we find the entrance to the Spinneret," Andrews said slowly, "they'll know it, too. Is that what the delaying tactic is all about?"

"Mainly. We really *don't* have any extra manpower, but some of the projects could be put off without major trouble. But for the moment I think we'd do better to stall."

There was a short pause. "I hope you're not expecting the Pentagon to rush lots of defensive weaponry to us," Andrews said. "Even if Congress didn't debate the issue for six months, they'll practically have to invent the kind of material we'd need."

"I know—space war weapons that do fine against spy satellites would be pretty useless against M'zarch cruisers. No, I'm counting on the people who already have the weapons."

"The Rooshrike?"

"And the Poms and Orspham and Whissst," Meredith nodded. "Tell me, what would you do as President if the Spinneret had been discovered in, say, Upper Volta and you heard that the Chinese had made a grab for it?"

"Send two squadrons of F-26's for their use and offer them anything else they wanted," Andrews said promptly. "So you want to stall long enough for all the aliens in the area to hear about the M'zarch attack?"

"Bull's-eye. I suspect the Rooshrike may spread the word on their own; if not, we'll send a message to the Ctencri trading group at Earth and let *them* do it."

Andrews nodded slowly. "Three

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weeks one-way for the *Pathfinder*. Any idea how fast Rooshrike ships are?''

''No, but we already know the Ctencri scrimped on the technology they sold us way back when. I'm going to guess—oh, a month at most for the other aliens to get ships here for close-range analysis of the situation. Until then we'll just have to hope the Rooshrike can hold off any other bargain-hunters.''

''And that the Rooshrike themselves don't get ideas.''

Meredith grimaced. ''There's that, too.''

''A truly great joke,'' the young Whist said, snapping his ripper claw with a gesture of extreme pleasure.

''A great joke, indeed,'' the older Whist facing him on the viewscreen agreed. ''Second only to the finding of the Spinneret itself.''

''True. And the M'zarch are normally such humorless people.''

''We should send a representative to Rooshrike space to see this thing.''

The young Whist pondered a moment. ''But such an action will have no humor at all to it,'' he said, touching a control with his left-most antenna. Above his compatriot's face a map appeared, accompanied by a list of numbers. ''The predictor calculates an eighty-nine fraction that the Whissst will take such an action.''

''I understand your reluctance, my scion. But you must learn the fact that not all one's actions may be humorous. In this case it is more profitable to have a representative available to observe than to extract a joke from the situation. Besides—'' the older Whist twitched his antennae—''who knows what jokes the Spinneret has yet to offer?''

''True. I would rather take humorous action when dealing with offworlders, but I accept your logic. I will place my calls.''

''Good.'' The screen blanked.

The young Whist wasted no time in keying the first number onto the screen, but even so the monitor informed him there would be a slight delay. Small wonder, with each of his same-year brothers trying to call their assigned less-year kin, each of whom would call five others . . . and likely other families had received the word and were engaged in similar operations. The pyramid was undoubtedly an efficient way to pass news, but there was no humor whatsoever in its practical application: the lines *always* jammed.

Still. . . . Gazing at the map, the young Whist brightened. Even if the Whissst *were* expected to go to Astra, the ships could trace a curve past Rooshrike space and come in from the same direction as the Orspham. A small joke, to be sure, but small was better than nothing.

The line cleared and the summons tone sounded. Settling his claws in the proper posture for greeting a less-year brother, he waited for the other to answer.

On the Pom home world the news went out as a rippling series of sonar waves, amplified at thousands of strategic points along their journey until they reached every reef and wavetop of the mighty ocean. To assemble the people took far longer, even with the speed and tirelessness Poms prided themselves

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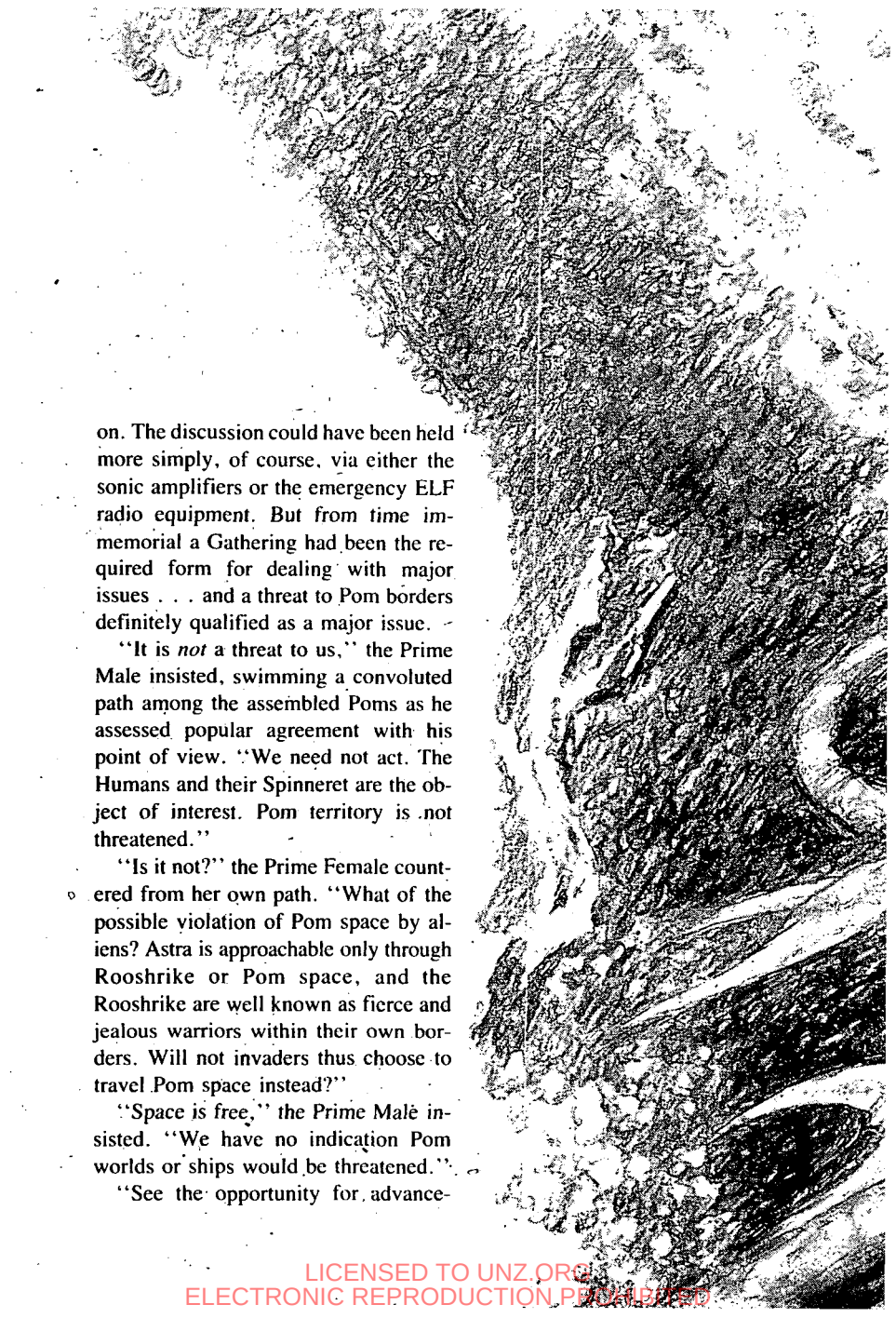

on. The discussion could have been held more simply, of course, via either the sonic amplifiers or the emergency ELF radio equipment. But from time immemorial a Gathering had been the required form for dealing with major issues . . . and a threat to Pom borders definitely qualified as a major issue.

"It is *not* a threat to us," the Prime Male insisted, swimming a convoluted path among the assembled Poms as he assessed popular agreement with his point of view. "We need not act. The Humans and their Spinneret are the object of interest. Pom territory is not threatened."

"Is it not?" the Prime Female countered from her own path. "What of the possible violation of Pom space by aliens? Astra is approachable only through Rooshrike or Pom space, and the Rooshrike are well known as fierce and jealous warriors within their own borders. Will not invaders thus choose to travel Pom space instead?"

"Space is free," the Prime Male insisted. "We have no indication Pom worlds or ships would be threatened."

"See the opportunity for advance-

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ment,'' the Second Female suggested, her path interweaving that of the Prime Female to indicate their basic agreement. ''The Spinneret cable has many potential uses, as do the other technologies involved. To purchase from the Humans will undoubtedly prove easier than to purchase from a successful invader.''

''To strengthen our border defenses thus serves our interests twice,'' the Prime Female added.

''It is interstellar politics,'' the Prime Male said. ''No concern to Poms.''

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jog your mind

run to your library

American Library Association

The discussion lasted nearly a day, but at the end of it over half of the assembled Poms were swimming intertwining paths with the Prime Female. The voting finished, the Gathering was dispersed, and the Prime Male relayed their decision to the messenger ship circling high above the waves.

Within a few days the ships began to gather at the border, sealing off Pom space as had never before been done in peacetime.

From that direction, at least, the Spinneret would be safe from invasion.

For the Orspham there was no disagreement whatsoever. The M'zarch had tried to take Astra, and the Orspham would do all they could to make sure there would be no further attempts along such lines. A diplomatic mission would be sent immediately to the Humans' home world to offer defensive military assistance; a military force would wait just outside Rooshrike space for permission from both Humans and Rooshrike to proceed to Astra.

It wasn't simply the traditional rivalry that prompted such a response. Even the Orspham recognized the M'zarch nose for valuables; and if the M'zarch thought the Spinneret worth risking war with the Rooshrike it must be very valuable indeed. Until the Orspham had ascertained the full extent and particulars of this value, it was merely good sense to keep the planet out of M'zarch hands.

The Orspham might be slow, but they weren't stupid.

Of all the races in the area, it was the Ctencri who perhaps saw clearest the

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full implications of both the M'zarch attempt and its failure.

Mentally replaying the Rooshrike report, First Trader Sen held a *semarin* vial to his nostrils. *A technical act of war,* he thought miserably. *And repulsed by the Humans through direct use of the Spinneret technology. Military use, right from word one.*

It wasn't exactly an unexpected development—all technology *could* be adapted to warfare, after all. But now the military applications would be uppermost in everyone's minds, and that would complicate sales efforts tremendously. Demand would certainly go up, as no one would want to be caught without weapons or defenses others already possessed. But balancing that would be the climate of tension the Ctencri would have to work in.

And, of course, there was always the uncomfortable possibility that a race with genuine interstellar capabilities would gain total control of the technology. For the Humans to be given adequate defenses without simultaneously providing them with offensive capabilities was going to be a sticky problem, particularly as the Humans couldn't be allowed to suspect they were being treated like rash cubs.

Well. The first thing that would be needed would be faster communication between Earth and her colony. It was strict policy to keep the more advanced star drives away from younger races, but with some maneuvering the plans could "accidentally" fall into Human hands. . . . No. No, it would be both faster and safer simply to provide them a pair of unarmed courier ships with sealed drives. As free gifts, the First Trader decided; a gesture of good will that would subtly put them into Ctencri debt.

The *semarin* vial was empty, the volatile perfume having apparently evaporated several minutes ago without Sen's noticing. Tossing the vial toward the recycler opening, he hummed on the intercom and ordered Secretary-General Saleh to be contacted.

It was an odd feeling, a detached part of Saleh's mind noticed, to be at the same time greatly relieved and absolutely furious. *The M'zarch will pay for this,* he thought blackly. *By all that is holy, they will pay.*

With a supreme effort, he choked down his rage, bleeding it off to a half-unconscious pool where it could simmer until the time for vengeance was ripe. He thought in silence for several minutes; then, picking up his phone, he punched President Allerton's secure number.

"I've just received a message from the Ctencri, Mr. President," he said, dispensing entirely with the usual social pleasantries. "A force of M'zarch soldiers has tried to overrun Astra."

Allerton's eyes narrowed, but he remained silent as Saleh recounted the incident. "Did Trader Sen say whether the Rooshrike were going to remain on guard over Astra?" he asked when the Secretary-General had finished.

"According to him, they'll stay there as long as we want them to. But I don't expect they're doing it for free."

"Um. You suppose their fee will involve some of the Spinneret technology?"

"Possibly. But that's not the point.

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No man or group of men can claim possession of land they cannot defend. We have been shamefully negligent in this area, and it is by the grace of God alone that we have a second chance."

"What are you suggesting we do?" Allerton asked calmly. *Too* calmly, in Saleh's opinion. Where was that warmongering, saber-rattling American belligerence when you truly needed it?

"I'm suggesting we get some real weapons to Astra immediately," he ground out. "Anti-aircraft missiles, certainly; equipment for ground warfare, probably. And we'll need to arm our ships, too—"

"Who's going to pay for all this?"

For nearly a second Saleh completely lost his voice. "Have you perhaps forgotten those are *your people* out there?" he snapped when he found his tongue again.

"So you want *us* to foot the bill for these useless weapons," Allerton nodded. "That's about what I expected."

"*Useless?*"

"You don't seriously think anything we can make will be effective against the kind of military technology we'd be up against, do you? Our only chance would be to buy state-of-the-art weaponry from the Ctencri—and I doubt seriously they would sell that to us."

Saleh stared at Allerton's image, again forcing his temper down. "All right, then. If we *can* find a supplier of such weaponry, will you help pay for it?"

"Possibly," Allerton said. "It depends partly on who would have control of the weapons and how you would guarantee they wouldn't show up later in various national arsenals."

"We—the United Nations—would retain control, naturally."

"That's a little vague. Do you mean the Security Council, the General Assembly, or just the Secretariat?"

Saleh favored him with a long, cool gaze. "You don't trust us, do you?"

"As you've so often pointed out, Mr. Saleh, all Ctencri contacts run through the UN. Given the anti-West invective that seems to be a staple of Assembly speeches, I think I have a right to be concerned when you start talking about hasty weapons deals."

"Yet you are offended when I suggest the benefits of Astra and the Spinneret should be more evenly distributed."

"That's a different situation entirely, and you know it."

"Of course I do. But world opinion is seldom so rational." He paused. "So I'm giving you advance warning as to my plans. One: I'm going to make public the full details of the Spinneret's discovery and capabilities tomorrow morning, along with the Ctencri report of the M'zarch attack. At the same time I'm going to introduce a resolution in the Security Council that the UN take over the operation and defense of Astra."

"The United States will veto any such action," Allerton cut in sharply.

"So you've told me. And two: I'm going to authorize the formation of an international scientific task force to study the Spinneret and its cable. They will be transported to Astra aboard one of the new courier space ships the Ctencri have generously offered us—ships that will make the one-way trip in approximately four days."

He had the satisfaction of seeing Al-

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lerton's expression twitch at that. "So. Faster ships," the President said slowly. "Well, if you're expecting a communications advantage like that to shake us off Astra, you're going to be disappointed. What Astra needs most is a stable source of supplies, and I doubt your little couriers are going to have anything near the capacity of our ships."

"True. But who knows? In a month you may be leasing those ships to us—because I assure you, Mr. President, that the Spinneret will not remain long under the domination of you or any other single nation. It is the property of *all* mankind, and I intend to make that status both explicit and legal. I suggest *you* decide just how graciously you will bow to the inevitable. Good day, sir."

Allerton was still staring blackly at the camera when Saleh cut off the connection.

CHAPTER 15

Meredith had guessed the political ripples of the M'zarch attack would take a month to return to Astra, but in fact the ships started arriving barely ten days after the incident. Three warships from the Orspham Empire were first, hulking monstrosities that completely dwarfed the Rooshrike corvets that escorted them in from the border. The Whissst arrived a few days later, their ships much smaller and reminding Meredith of nothing so much as large, steel-plated pretzels. The Ctencri sent no warships, but the flying warehouse they brought was a gadgeteer's delight, judging by the catalog they transmitted groundside. As each race arrived Meredith did his best to send properly courteous greetings, and gratefully acknowledge their offers of assistance and defense without actually accepting any of it.

"I feel like an Exxon heir at a gold diggers' convention," he grumbled to Major Barner one afternoon in the latter's Crosse office. He seemed to be spending a lot of time in people's offices lately; the thought of all the radio monitors overhead had made him increasingly leery of the phone for anything but the most innocuous conversations. "You can practically hear dollar signs dropping every time one of them calls down."

"Except with the Orspham," Barner nodded. "They seem more interested in finding a M'zarch ship to shoot up. Have you figured out yet what you're going to do about all of them?"

Meredith grimaced. "Not yet. It's obvious we're going to need *some* protection, if only to keep the M'zarch from taking another crack at us. The only problem is making sure the guards we pick don't decide at some point that robbery would pay better." He shook his head. "Never mind that for now. We can afford to string them along for a while longer. Did you really want me here to discuss the harvesting, or is this more from Hafner's people?"

"The latter." Barner unfolded a map and indicated the new areas of crosshatching. "They've eliminated three more hills and most of the ridge that overhangs that end of the Dead Sea."

"Um. Still using that sonic echoing gadget Brown's people cobbled together?"

"And hoping slabs of cable material don't play games with sound waves as well as electric fields, yes. So far noth-

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ing that looks like a cavity has shown up."

"Have they talked to Dr. Chang's team about that? I don't know if they've done any sonic studies on the cable, but they should be able to rig up something."

"Probably could." Barner hesitated. "I don't really think Hafner's people want Chang in on this, though."

"The hell with what they *want*," Meredith growled. "We've got a set of experts here and we're going to use them. What does Hafner think this is, some new version of keep-away?"

"I don't think Dr. Hafner cares that much, himself. But some of his people—well, *resent* the way Chang just came in and took over up at the cable site."

For an instant Meredith remembered how Captain Witzany had reacted to that same event. "This whole place better start remembering that Astra is a territory of the United States, not some free and independent country. You'll send a messenger to Chang this afternoon to ask about the cable's sonic characteristics." He caught the objection in Barner's eyes and mentally backed up a step. "You don't have to tell him why we want the information, though."

"That'll help." Barner pushed the map to one side, replacing it with a sheaf of photo enlargements. "Dr. Hafner also took an extensive set of photos of the area and suggested we try shape analysis on the hills. I think it might be worth a try."

"Yeah." Meredith picked up the top photo, glanced at the one beneath it. "Unfortunately, it would mean putting all this on the computer, and I'm still not sure I want to risk that."

Barner shrugged. "I'll admit my knowledge of computers is limited, but it seems to me that if you tore out the entire remote-access system the thing should be secure enough. No one's going to eavesdrop on buried fiberop cables from thirty thousand kilometers, and the machine itself should be adequately shielded."

" 'Should be' is about as far as I get, too. Given our truly abysmal ignorance of the local state of the art in such things, it's not very reassuring." The colonel dropped the photo back onto the stack. "You might as well put all these into your booby-proofed file. I'm going to have to get back to Unie—some sort of silly resolution Carmen Olivero told me the council was taking up this afternoon. Keep me informed on Hafner's progress."

"Yes, sir."

Heading back outside, Meredith paused beside his car and peered for a moment toward the south. Two harvesters were visible in the fields, working to bring in the meager crop. Nearly thirty percent of the plants had died under the shock of having their trace metals twice yanked out of their soil. *I hope the* Celeritas *is bringing plenty of extra food,* he thought, climbing behind the wheel and starting the car. *And lots of spare fuel, too.*

The last speech—Perez's, as usual—was already in progress when Meredith finally showed up, choosing a chair by the door instead of joining the others at the table. Carmen shot a brief look of annoyance his direction and then re-

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turned her attention to Perez and the other faces around the table. The outcome, unfortunately, was no longer really in doubt. From previous speeches and the accompanying applause it was clear that at least six of the ten councilors were strongly in favor of Perez's resolution, and of the four remaining only two were definitely against. She'd hoped to at least get a tie situation, where she would have the deciding vote, but it was obviously not going to happen.

Perez sat down, and Carmen waited for the applause to run its course. "Further comments?" she asked. "Then we'll proceed directly to a vote. All in favor. . . ?"

The tally was a solid seven to three. Suppressing a grimace, Carmen turned to Meredith. "Colonel, the Council of Astra calls on you to issue an order barring all but Astran citizens from approach or examination of Mt. Olympus, the cable lying north of Wright, and all alien technology and artifacts that may be subsequently uncovered. Specifically, this order is to include both those members of Dr. Chang's group already on Astra and the various alien representatives currently in this solar system."

"Request denied," Meredith said briskly. "Any other business you want me here for?"

A ripple of displeasure went around the table, and Carmen braced herself for the inevitable outburst. But Perez kept his poise.

"I'm afraid you don't understand, Colonel," he said calmly. "This is one resolution you're not going to simply sweep away into a corner somewhere. We've done our homework on this one: I have petitions signed by seventy-two percent of the inhabitants of Ceres that support this resolution, and other councilors have similar proofs of support from their districts. The Spinneret belongs to Astra, Colonel, and neither you nor the faceless bureaucrats in Washington are going to take it away from us."

Meredith regarded him coolly. "You have a remarkably poor memory for certain facts of life, Perez, such as those dealing with your citizenship and my authority here. I'm at perfect liberty to ignore anything you or your seventy-two percent have to say—and if you get rude about it I can toss the lot of you into detention."

Perez didn't bat an eye. "It wouldn't be nearly as neat and tidy as you make it sound. If you don't throw Chang's group out immediately, I can guarantee there will be rioting—and *this* time I won't be trying to hold anyone back."

Meredith didn't move or change expression, but suddenly Carmen had the uncomfortable feeling that perhaps Perez had pushed the colonel a shade too far. "In such a case, Mr. Perez," Meredith said, his voice deadly, "neither would I."

"Of course," Perez said. "And you would win . . . but only temporarily. Because signs of civil strife down here could very possibly persuade one or more of the aliens out there that we needed some strong, neutral hand on us—strictly for our own good, of course—and take the appropriate action."

The room was very quiet. Meredith never flinched or broke eye contact with Perez, but Carmen sensed his frosty si-

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lence was a simple lack of any answer to that. After a few seconds Perez pulled a thick folder from the stack of papers in front of him and added to it a copy of the council's resolution. Standing, he stepped over to Meredith and offered him the bundle. "I think you'll find, Colonel," he said, "that above all else we *must* present a united front if we're going to survive here."

Tight-lipped, Meredith got to his feet and accepted the papers. "We'll see," he said shortly. With a single glance at Carmen he turned and left the room.

Carmen licked her lips. "This meeting is adjourned," she said, banging her makeshift gavel with rather more force than necessary and immediately turning her full attention to loading her briefcase. The others took the hint and began packing their own paraphernalia without protest and with a minimum of quiet conversation. She waited until the last sounds of footsteps were cut off by the closing door before permitting her chosen expletive to come out.

"Agreed. And I apologize."

She looked up, startled, to find Perez sitting quietly in the chair Meredith had recently vacated. "I thought you'd slithered out with the others," she snarled.

He shrugged. "I wanted to make sure you were all right. And that you understood why I'm doing what I am."

"I'm fine," she bit out, getting to her feet. "And you don't need to explain the finer points of blackmail technique to me, thank you."

She tried to step past him, but he rose and took her arm, and before she knew it he had steered her back to the table and seated her again. "You're angry because you don't agree with my methods," he said, sitting down next to her. "But I'm afraid it's a simple fact of history that the only way a ruling class is ever persuaded to share power is through violence—either actual or threatened."

"So why don't you just go ahead and ally yourself with one of those aliens out there and do the job right?" she said bitterly.

He sighed. "I'd hoped you would grow to understand what I stand for better than that. Don't you see?—I'm not trying to exchange one inequity for another. Astra can be this century's version of the Americas, a place where people can come to escape the foolish rigidity of Earth politics. But that can't happen as long as we're simply a transplanted chunk of the U.S."

"And what are you going to feed all these tired, huddling masses when they get here?" she shot back. "We can't even grow enough to feed the ten thousand people we've got."

"We can feed them anything they want—up to and including imported caviar. Or haven't you considered what our Spinneret cables might sell for?"

She shook her head. "Your ideas of marketing show the same shallow thinking your politics do. If the cable turns out to be really useful it's not going to be ours much longer, not with all those warships circling overhead."

"We can handle them," he assured her. "Playing big powers off against each other is a skill the Third World is well acquainted with."

She laughed, a short, derisive bark. "Oh, terrific. You scramble to get us free of American politics and instead turn us into a transplanted Yugoslavia

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spending all of our energy juggling the local superpowers. What a *great* improvement."

She had the satisfaction of seeing him struggle to fight down his own anger. "The position the Spinneret has put us in isn't my fault, Carmen. I don't like it better than you do, but sitting around wishing things were different won't change anything." He paused. "I'm sorry, though, that you can't slough off that middle-class upbringing long enough to see things from the point of view of the less fortunate. I see I've been wasting my time with you."

So all of it *had* been deliberate. She'd wondered about that, ever since his message to Meredith through her had started this whole Council mess. "You flatter yourself," she said, again getting to her feet. "It's you and your methods, not any sort of upbringing, that's soured me on your planned utopia."

"Carmen—"

She shrugged off his hand. "And as long as you've got all the answers, consider what all your huddling masses are going to do for a living once they get here. Or are you just going to distribute the Spinneret income evenly and let people sit around all day like overgrown parasites? If that's your idea of a satisfying existence, you're more foolish than I thought." With that she turned and strode out of the room, slamming the door behind her.

She was outside the building and halfway back to the admin complex before her anger cleared enough for her to think straight again. She slowed down, looking at the dull adobe buildings around her as she walked. After living in modern military bases, Astra had always seemed almost like a throwback to the 1800s to her . . . but never until now had she noticed its complete vulnerability, both to external and internal attack. *What,* she thought miserably, *am I going to do?*

On one level the question was trivial; on another, impossible. She would certainly go and see Colonel Meredith immediately, offering whatever assistance she could to block Perez's power grab. How that end could be accomplished, though, was another matter entirely.

The quiet burp of a distant sonic boom penetrated her thoughts, and she looked westward in time to see a shuttle drop toward Martello Base. An alien delegation? It could be nothing else; it would still be a couple of weeks before any kind of reaction to the M'zarch attack could arrive from Earth. Quickening her step, Carmen changed direction to head for Unie's docks. The colonel would almost certainly have gone to the base to greet the visitors, and she saw no particular point in sitting around his office until he came back. Besides which—it suddenly occurred to her—as moderator of the Council her visible support of Meredith in any discussions might help short-circuit Perez's scheme to promote disunity.

The armed guard waiting at the docks was a surprising but welcome addition to the scenery; apparently, Meredith was taking Perez's threats seriously. Carmen half expected to be denied access to the boats, but her military ID proved acceptable, and soon she was guiding a roaring motorboat up Splayfoot Bay toward Martello.

There were ten of them in all, and the

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names on their identification papers were as prestigious as any on the UNESCO listing. They sat quietly, for the most part, some of them gazing out the window at the Martello landing area or the hills of the mainland to the east.

The four UN officials accompanying them had equally prominent names, but not anything like the scientists' patience as Meredith went through their credentials one by one. Possibly, he thought, they felt insulted that he'd chosen to meet them in Major Brown's office instead of ferrying them to Unie and his own. Perhaps he should have; the trip would've given him that much more time to think.

Finally, he could stall no longer. "I must say, first of all, that Astra is honored by your presence," he said to the scientists as he returned their papers. "Under other circumstances you would be most welcome . . . but I'm very much afraid you may have made this trip for nothing."

"Would you care to explain, Colonel?" Ashur Msuya said, his voice cold. Meredith had never before met the man, but his virulent anti-West oratory had for years been one of the main rallying points for what little unity the African Bloc was ever able to muster. He'd been merely the head of the Mozambique delegation when Meredith had left for Astra, but his credentials were now identifying him as Assistant Undersecretary for Trusteeship and Non-Self-Governing Territories—a change in position Meredith found more than a little suspicious.

"It's actually rather simple, Mr. Msuya," the colonel said, turning slightly to face the other. "I've been given command of Astra—*all* of Astra—by the United States government, and there's no legal way I can relinquish that authority to you or anyone else without direct orders from my superiors or from President Allerton."

Msuya's lip curled. "Yes, I rather expected you to quote regulations of one sort or another. However, Astra is United Nations territory, and we don't need the Pentagon's permission to withdraw the mandate your government was given. If you insist on being legalistic, I can also argue that the Spinneret and its cable are alien devices not really part of Astra at all, and that your mandate does not include them. Either way, we wind up in control of the Spinneret."

"Mr. Msuya, again I say that without orders I can't simply take your word for that—and all these papers still boil down to being your word. Now, if our regular supply ship brings me such orders, that'll be a different matter. But until that happens. . . ." He shook his head.

"Suppose your ship doesn't say anything one way or the other?" one of the scientists spoke up.

"Then I'll send a message back with her captain describing your mission and requesting instructions. The round trip would take about six weeks, I'm afraid."

"Our ship could bring you a response in eight days," Msuya pointed out. "It's an advanced craft—one of two the Ctencri have given the UN."

"Interesting. How much is Saleh paying for them?"

"They were free gifts."

Sure they were, Meredith thought. "Of course," he said aloud. "But I'd prefer using American ships for any such messages."

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Msuya leaned back in his seat and regarded Meredith coolly. "In other words, you choose to stall. All right, have it your way. I trust you'll at least be willing to find accomodations for the scientific team down here while they work on the cable. I and my delegation can stay aboard our ship if you'd prefer."

And here was where the organic fertilizer was going to hit the fan, Meredith thought with a sinking feeling. He had no intention of letting a group of foreign nationals get at the Spinneret cable, UN instructions or no. "I would be honored to host these distinguished ladies and gentlemen," he said, "but as for examining the cable, I'm afraid that won't be possible."

"Colonel Meredith." With deliberate movements Msuya rose from his chair and stepped up to the edge of the desk. "It's clear you don't care that your career is being endangered by your uncooperative attitude; I presume that if I had an armed force of troops available you would be equally contemptuous of your life. But I tell you *right now*: *you* are now endangering your entire country. We know you have U.S. scientists here studying the cable; failure to grant equal access to us will raise serious questions as to American intentions. It could easily lead to an immediate embargo of all alien goods and technologies both to you and to the U.S.—and I assure you that the embargo will be an airtight one."

He paused for breath, and Meredith moved into the gap. "I understand your concerns," he said, "but I can assure *you* we have no intention of withholding information on the cable from anyone." He shifted slightly in his chair, wondering what he was goind to say next; and as he did so the paper in his coat pocket crinkled. A gift from heaven, and he grabbed it with both hands. "But I think you've jumped to a false conclusion. It's not a matter of American versus UN scientists; the fact is that *all* non-Astrans are going to be barred from the cable, at least for now." Pulling out the copy of the Council resolution Perez had given him, he handed it over.

Msuya scanned it, his frown heavy with suspicion. "What is this *Council* fabrication? Astra's supposed to be under military rule."

"Americans are very democratically inclined people," Meredith shrugged. "The Council was set up shortly after our arrival to act in an advisory capacity."

"Then this resolution has no legal force behind it." Msuya tossed the paper back onto the desk.

"It has the force of public opinion," Meredith told him. "In America we consider that important."

One of the scientists cleared her throat. "You say *all* non-Astrans have been ordered away from the cable, Colonel?"

Meredith saw the trap. "I was about to issue the orders to Dr. Chang's team when I was notified your delegation was arriving. The Council's resolution was passed less than an hour ago."

"Perhaps we should give you a few minutes now to do that, then," she replied.

There wasn't really any way out of it. Raising his phone, he keyed for Andrews, waiting outside in Brown's outer office. "Lieutenant, I want you to go

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up to the cable site and have Dr. Chang's people brought back here. Pull copies of all their data, too. Then get in touch with Captain Witzany and put him back in charge of all cable testing."

One of Andrew's best qualities was his ability to accept even strange orders without question. "Yes, sir. I presume the scientists are to come whether they want to or not?"

"Correct. If they have any complaints, tell them it'll all be explained when they get here."

"Yes, sir. Uh, Miss Olivero is here, Colonel, and seems anxious to see you."

Chair of the Council. . . . It was a chance, Meredith realized, to add authenticity to his position. Provided Carmen was smart enough to pick up on what he was doing. "Please ask her to come in," he told Andrews.

The door opened, and Carmen stepped inside, her face set in a decidedly neutral expression. Meredith wished fleetingly he knew how much, if anything, Andrews had told her about their guests. "Carmen Olivero, current chair of the Council of Astra," the colonel introduced her, rising to his feet. "This is Mr. Msuya of the UN Secretariat; I've just had to inform him of the Council's decision to forbid non-Astrans from direct access to the Spinneret cable."

For a long moment he thought she was going to bring the whole house of cards down. Her eyes, which had been sweeping the group, cut abruptly back to him, widening in surprise. But only for a moment. "I see," she said. "Well. I'm glad you decided not to bother appealing the resolution; with a seven-to-three margin it would've been useless, anyway." She focused on Msuya. "Were you expecting to take over the cable studies, sir?"

"The cable is UN property," he told her coldly. Turning back to Meredith, he added, "I don't know what you expect to gain by this charade, Colonel, but rest assured that no one in this room is in the slightest taken in. You're going to bring in the American scientists, make a big show of taking them off the project—and the minute we're gone they'll be back at work."

"I'm sorry you think me so underhanded," Meredith said, matching the other's tone. It was time he showed some irritation at all this verbal abuse. "You and Dr. Chang can compare notes on my character on the trip back to Earth; I'm sure he'll have one or two things to add by then."

Msuya blinked, and for the first time a hint of uncertainty showed through his animosity. "What do you mean?"

"Well, we certainly can't afford to feed any extra people here," Meredith said calmly. "I just assumed you wouldn't mind giving them a lift home. It *is* only a four-day trip, you said?"

Msuya took a deep breath, turned back to gaze at Carmen, still standing just inside the door. "So your civilian Council presumes to dictate to an authorized military commander, does it? What do you think the U.S. Congress is going to say when it hears about this? Or the Pentagon? I expect they would appoint a new commander rather quickly."

Meredith held his breath . . . but Carmen had clearly figured out what was going on. "I don't see that the Pentagon or anyone else has any cause to

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complain. Your average military base isn't ninety percent civilian, either, and I can vouch for the fact that the Council has made the colony run smoother." She fixed Msuya with a steely gaze. "As I recall, that *is* what the UN mandate called for: to establish and maintain a viable settlement on the world Astra; to choose, equip, and train such personnel as may be deemed necessary and sufficient—"

She rattled off the whole General Purpose section from memory, and when she was finished even Msuya looked grudgingly impressed. "I see you at least put someone with legal experience in charge of your Council," he said, turning back to face Meredith. "But you're digging yourself into a hole where you will literally starve to death. You can throw us off Astra *now*, yes, but how long will you survive when the UN cuts off all food and supply shipments to you? How long could you hold out if the Security Council voted to send a military force to deal with your blatant disobedience?"

Meredith couldn't help it; he laughed out loud. "A *military force?* Have you *seen* the collection of warships riding around us out there? Damn thing looks like a three-dimensional traffic jam—and every one of them ready to jump at the slightest suggestion that we're being invaded. I suggest you bear that in mind when you start talking about military action."

For a moment the two men stood there, gazes locked. Meredith waited long enough for the tension in the room to get good and thick. Then, dropping his eyes to Brown's computer console, he keyed for a status report. "Your shuttle has been refueled and will be ready to lift in about an hour. Before you leave I'll ask Major Brown to give you a tour of the Martello Base facilities."

"This is outrageous!" one of the scientists snorted. "Mr. Msuya—are you going to let him just throw us out?"

Msuya's eyes were still boring into Meredith's face. "For the moment, Doctor, there is little else I can do. But that condition is temporary. Very temporary."

Meredith phoned for Brown and endured the minute of stony silence it took the major to arrive. He half expected Msuya to hurl some final threat as Brown led them out, but the undersecretary passed up the chance for last-minute dramatics. Carmen started to follow the group; Meredith signaled her to remain. The door closed and she let out a long, sighing breath. "You shouldn't have laughed at him, Colonel," she said.

Suddenly weary, Meredith sat down again behind the desk. "I know, but that particular threat was *so* ridiculous. Not that is matters, really—Msuya couldn't possibly get madder than he already is." He shook his head. "What did you want to see me about? Andrews seemed to think it was important."

She smiled lopsidedly. "Actually, I came here to offer whatever help I could to head off Perez's power play. I see I was a little late."

"Not at all—both your timing and assessment of the situation were perfect."

"I meant—never mind."

"You meant you missed the episode where I switched sides?"

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She flushed. "Well . . . yes. I was a little . . . surprised by that."

"Yeah. My own fault, too—I should've expected the UN to try a direct takeover and been better prepared. They moved a lot faster than I thought they could."

There was a moment of silence. "What happens now?" Carmen asked. "Are you really sending Dr. Chang home?"

"I have no choice. You saw Msuya's expression—he's just itching for a chance to come down like a Marine battalion on either Astra or the U.S. Throwing everyone off Astra like this should get the U.S. off the immediate hook, though there'll now be pressure on the President to replace me. I hope he understands what I'm doing and can stall them."

"What if he can't? I have to tell you, Colonel, that legally you're on very soft ground. Council or no, you're still the one who's ultimately responsible for everything that happens on Astra . . . and the UN *would* be well within their rights to cut off our supplies."

"Um." Meredith stared out the window for a moment. Like the courier ship still in orbit, the UN delegation's shuttle was clearly of alien design—another "gift" from the Ctencri, no doubt. Meredith had never been as opposed to the UN as some of his colleagues were, but this business of the organization's being sole contact for alien trade was beginning to look ominous. It was putting far too much power into the hands of the Secretariat, and he wondered fleetingly whether Msuya's presence here had been a play by that body alone. He'd offered no evidence of a Security Council vote, after all, and such a vote should be necessary for any altering of the Astran Mandate. Unless the U.S. had capitulated before the threat of economic sanctions and had voted with the majority. . . .

"All right," Meredith said abruptly. "As the saying goes, two can play this game." He keyed his phone for the base communications center. "Put a call through to the nearest Rooshrike ship," he instructed the officer on duty. "Tell them I'd like a talk with Beaeki nul Dies na at his convenience." He got an acknowledgment and looked back at Carmen. "Is there anyone in your department who's ever handled trade negotiations?"

Frowning, Carmen leaned across the desk and started tapping computer keys. "I think Ruth Eldridge might have. . . . No, that was a labor dispute." She pressed more keys, but the screen remained blank. "Nothing like that in anyone's file, sir," she said.

"Damn. Well . . . how about you? You want to help me open up trade with the Rooshrike?"

She looked up at him, jaw dropping open. "*Me?* Why?"

"Why not? Common sense and a fast mind are at least as important as experience in something like this. Besides, as head of the Council you'll lend an air of authenticity that may keep Perez's crowd off my neck."

"But—Colonel, don't you think you're giving me just a little too much extracurricular work?"

He smiled in spite of himself. "Oddly put, but you have a point. All right; as of right now you're relieved of all your normal duties. I'll get you a priority number for materials and personnel by

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tonight or tomorrow morning, but try to use it sparingly."

"I understand." She sighed. "Oh, all right; I'll do it. What exactly do you want from the Rooshrike?"

"Ultimately, our own private channel to both U.S. and alien markets, one the UN can't shut off. Priorities right now are foodstuffs, heavy equipment—well, it's the same list that's on the computer. All the stuff we lost to the Spinneret's leecher."

"How about weapons?"

"None." His lip twitched at her expression. "Yes, I know I'm a military man and that we've already been attacked once. But our best chance of survival right now is to look and act as harmless as possible. Remember, the warships upstairs know even less about the Spinneret than we do—and they *don't* know we aren't in actual control of the thing. I've already had to deflect two or three veiled questions about the 'weapon' we used against the M'zarch landers, at least one of which concerned the thing's range. The minute we start looking militant I think they'd come to a pretty quick agreement on joint action."

"I suppose so," she agreed reluctantly. "I just don't like feeling so vulnerable."

"Neither do I, but for now it can't be helped."

She shrugged, as if dismissing the matter. "All right. Now, how are we proposing to pay the Rooshrike for whatever they get us?"

Meredith took a deep breath. He hated to do this, but could see no alternative. "We'll pay them—and any other race with which we do business—in lengths of Spinneret cable. The value per meter will be assessed later, once we've completed our tests on its material properties."

Carmen's dark eyes held his. "You're going to let the aliens buy the cable, just like that? Suppose one of them figures out what it's made of or how the glue works or something?"

"I don't think that's likely to be a problem," he returned dryly. "And even if they do, I doubt it'll hurt our profits any. If Dr. Hafner's right, the Spinners' factory could be the size of a small city, and I can't see the Rooshrike or Ctencri throwing one together overnight." He paused, but she still looked troubled. "You disagree?" he prompted.

"What about Earth? Are you going to give the UN or U.S. some cables free, or make them pay for it like everyone else?"

Meredith shook his head. "I don't know yet how we're going to handle them. My first inclination is to pay off the costs of the colony and then treat Earth as just another customer . . . but since the U.S. 'll get the lion's share of cable that way it's bound to cause a major stink at the UN. And this damn six-week communications lag doesn't help any—we could spark off a war and never even know about it until it was all over." He scowled toward the computer screen. "Let's add a couple of those fast courier ships to the Christmas list you're making. If the UN can get advanced drives, we ought to be able them, too."

"Yes, sir." She hesitated. "Colonel . . . before I came here I was talk-

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ing to Cris Perez. He's also starting to talk about selling Spinneret cable."

"Oh? I would've thought tawdry mercentile matters beneath him."

She flushed. "He's less interested in profits than he is in making Astra an escape hatch for Earth's poor. He sees the Spinneret as the cornucopia that'll make that possible."

"He would," Meredith grumbled. "Perez is a grade-ten idealist."

"Perhaps," she said noncommittally. "But you're now talking about a similar course of action . . . and either way I'm worried about what we'll do here with a sudden influx of wealth. I'd hate to see all of us sit back and loaf while the Spinneret pays the bills for us."

Meredith rubbed his chin. "I doubt that it'll come to that extreme. The cable may be strong as hell, but what can you really *do* with something shaped like cosmic spaghetti?"

"I don't know. But the Spinners apparently did."

"Yeah." For a moment Meredith stared past Carmen. An entire planet-worth of metal . . . quintillions of tons of it . . . all made into six-centimeter cable? *Why?* "You'd better go back to your office and get busy with your preparations," he said, instinctively pulling back from what could only be futile speculation. "I'd like to get Beacki's people down here tomorrow morning for a preliminary meeting."

She nodded and stood up. "I can be ready."

"Good. I'll let you know the time after I talk with the Rooshrike. Dismissed."

He glared at the desktop for a minute after she'd gone. So he and Perez were both thinking along the same lines for once, were they? An annoying thought, in some ways, but if handled properly it might enable him to take some of the wind out of the Hispanic's rhetoric. Even a brief respite would be helpful; between Perez, the UN, and the collection of alien ships overhead, Meredith was facing too many opponents as it was.

And speaking of opponents . . .

Hitching his chair closer to the terminal, the colonel keyed for the job file and began to type:

SEARCH ALL AVAILABLE ALIEN LITERATURE FOR HISTORICAL RECORDS, LEGENDS, OR MYTHS RELATING TO OTHER RACES, GOD-LIKE BEINGS, ETC. EMPHASIS ON ROOSHRIKE AND POM TERRITORIES. FULL ANALYSIS REQUESTED, INCLUDING CORRELATIONS AND COMPOSITES WHERE POSSIBLE.

Know your enemy, the ancient dictum went . . . and if the Spinners had left any other trace of their passage behind, Meredith wanted to know about it.

CHAPTER 16

The report was short and maddeningly uninformative, and Secretary-General Saleh slapped the last page onto his desk with a snort. "I don't suppose," he said sarcastically, "that you have any idea what these meetings with the Rooshrike are about?"

Ashur Msuya shook his head. Judging from his expression his own mood wasn't much better than Saleh's, but he knew better than to snap back at his superior. "Nothing positive. There's been nothing like a general announcement about changes in defense arrangements or anything. It's possible they're

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working on a trade agreement, but the shipments that the Rooshrike landed there could equally well have been in return for the cable they made off with after the M'zarch attack."

Saleh snorted. "Oh, it's a trade agreement, all right—Allerton is moving to open up an independent pipeline to the alien marketplace."

"Or Colonel Meredith is," Msuya offered, shaking his head. "I'm not really sure whose side Meredith is on these days."

"Forget your doubts. He's an American soldier on American-claimed soil. Any rifts that appear are purely for show."

"Perhaps. But either way I submit that it's high time the UN made a move to assert its rights on Astra."

"Your economic embargo of the colony, I presume?"

Msuya nodded. "Whatever agreement Meredith—or Allerton—is setting up, the Rooshrike can't deliver food that we don't let off the Earth."

"The Americans have their own starships—"

"Which now use Ctencri drives and are supplied from the ground by Ctencri shuttles. We can cut off the flow of spare parts and fuel cylinders any time we want. It would take months or longer for them to get their older shuttle fleet back in service."

Saleh pondered. He hadn't liked this idea much when Msuya first proposed it, and he didn't like it any better now. To put his hands deliberately to the throat of a colony he himself had helped set up . . . but then, it undoubtedly wouldn't come to that. The Americans would back down before they'd let their people starve. "You're sure their own crops won't be adequate?"

"Positive. Even after harvest, crop yield analysis can be done very accurately."

"And if the Rooshrike open up a shipping route to Earth . . . ?" Saleh smiled and answered his own question. "We don't let them, of course. Earth is technically within Ctencri borders, and we could simply ask them to keep Rooshrike traders out. Very well; I'll put the matter before Allerton this afternoon, give him a chance to back off on his Rooshrike deal."

"Why bother? You'll just give him that much more time to prepare for the embargo."

"Because if we proceed with so drastic an action," Saleh said coldly, "I want the world community to have no doubt that it was fully justified."

And whether it actually was or not was almost incidental. That much, at least, every politician knew.

Secretary of State Joshua Purvis looked about as surprised as Allerton had ever seen him. "*What* Rooshrike treaties?" he asked.

Allerton shrugged helplessly. "I gather it's something Meredith has initiated on his own, for whatever reasons. We won't know for sure for at least another week, until the *Pathfinder* comes in. Possibly not even then."

"So what'd you tell the Lord High Secretary-General?"

"I tried to stall, of course—told him that I couldn't take any action or make any statements until I had Astra's own report on what was going on out there."

"He buy it?"

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"Not really. He offered to fly a U.S. representative out in one of their new Ctencri ships to assess the situation and give any appropriate orders." Allerton paused, then picked up a piece of paper from in front of him and handed it across the desk. "Complicating matters, I'm sure, a Ctencri ship arrived only half an hour ago and delivered this to Saleh's people. I don't suppose it improved his patience any."

Purvis scanned the paper briefly. "This is, what, the results of the Rooshrike tests on their Spinneret cable? . . . Holy Mullah." He looked at Allerton. "This *has* to be a misprint, John. A *billion* pounds per square inch?"

"Check the footnote—that's a *minimum* tensile strength. Apparently even the Rooshrike weren't able to break it."

"But a *billion pounds per square inch?*" Purvis fumbled with his calculator. "That means . . . one of those cables could lift over two million tons. That's half a fully loaded supertanker."

"And don't forget it's less dense even than water, let alone normal metals," Allerton pointed out. "Now remember that superglue coating and its unique superconducting properties, and consider that Saleh thinks we're trying to keep all of it for ourselves."

Purvis studied the paper for another few seconds, then put it back on the President's desk. "I think," he said quietly, "that we'd better figure out right away exactly what our policy position here is—and then make sure Meredith is operating in line with it." He hesitated. "Whether we're willing to go on being unpopular with the rest of the world because of Astra is your decision, of course. But I think that stand could use a little re-evaluation."

"In other words, you think we should knuckle under to Saleh and just hand over Astra and the Spinneret to the UN?"

"I didn't say that." Purvis shrugged. "But an embargo of food to Astra would be hard if not disastrous for them, and it's only the tip of the iceberg as far as Saleh's options go. Legally, we may have some mandate rights to the Spinneret cable, but in practice as long as Saleh's got the Ctencri in his pocket he can keep us from getting a single strand of the stuff. In any real confrontation the *Aurora* and *Pathfinder* might as well be space-going tuna boats."

Allerton grimaced. "You think the Ctencri would give the UN *armed* ships?"

"Before the Spinneret came along they apparently wouldn't even give us advanced star drives; Saleh's now got two. I think the Ctencri see a chance to get in good with the offical owners of Astra and are grabbing it. Who knows how far they're prepared to go to protect their investment?"

"Yeah." Allerton sighed. "Well, then, I suppose we'd better take Saleh up on his offer of a lift out to Astra. Try to straighten things out as quickly as possible."

"You want me to go?"

"No . . . no, I think I might just go myself." He smiled lopsidedly at Purvis's expression. "Come on, Josh—space travel's supposed to be as easy as crossing the Delaware these days. And a lot safer."

"Unless Saleh decides he'd like you put on indefinite hold," the other said

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bluntly. "In which case you could hardly give him a better opportunity."

Allerton waved the objection aside. "Saleh's neither strong enough nor desperate enough to kidnap a head of state. Not yet, anyway."

"Maybe," Purvis said. "Maybe not."

"It's so nice to be invited here, for a change," Perez commented as he sank into the chair across from Meredith. "Usually I have to bully your secretary to let me in."

Meredith's expression remained studiously neutral, and Perez mentally crossed off the possibility that the colonel had a social chat in mind. "I understand," Meredith said, "that you're thinking about the possibilities of making some spending money off the Spinneret cable."

"That's right," Perez nodded. "And I understand you're actually going to do so."

The colonel's eyebrows rose fractionally. "Miss Olivero told you?"

"She confirmed what I'd already guessed. Was it supposed to be a secret?"

Meredith smiled sardonically. "Don't you wish. Secret deals by the corrupt military dictator—it would have been made to order for you."

"That's a little unfair, Colonel," Perez said, feeling his face warming. "I don't deliberately distort the truth—I just try and keep others from doing so."

"Of course." Meredith tapped computer keys and swiveled the screen toward his visitor. "Well, here's a little bit of truth for you—see what you think."

Perez leaned forward. *Preliminary Analysis of Alien Cable*, he read . . . and suddenly he knew what this was. "It's the Rooshrike test results, isn't it? Is this why you're keeping the trade deal quiet?"

"We've been keeping the *negotiations* quiet; no deals have been made yet. After all, we needed to know more about the cable in order to fix a fair price for it."

"You're going to use the Rooshrike's own numbers for that purpose?"

Meredith shrugged. "I know what you're thinking, but there's no real way around it. The Rooshrike have both better testing equipment and a better feel for what the cable would bring on the open market."

"Mm.", Perez thought for a moment. "Perhaps if we offered them a small percentage of what we get from sales to other races . . . that might deter them from suggesting too low a price."

"As a matter of fact, Miss Olivero had already put that idea to the Rooshrike representatives. They seem agreeable to it."

"I see." *A woman of many talents*, Perez thought with mild surprise. He'd done a little trade negotiation himself some years back; just enough to know that he didn't care for it. Of course, Carmen had the distinct advantage of a seller's market to work with here. "What price range are you talking about?"

"Our current thought is to charge about forty million dollars per kilometer plus the two and a quarter tons of metal that go into a cable that long."

Perez whistled softly. "That seems rather expensive."

"It's less than twice the current price

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of gold," Meredith pointed out. "And a *lot* more valuable."

"For study, perhaps. But aside from building long suspension bridges I would think its uses limited."

"You would, would you?" Meredith leaned back in his chair and started ticking off fingers. "One: loop it back and forth—it's flexible enough—so that each segment lies next to the one before. The glue sticks the whole thing into what is essentially a flat plate; coat it on all sides to take up the rest of the glue and you have sixty square meters of impenetrable material. Put another cable on each corner and get yourself a strong crane and you've got a sling you could carry small mountains around with. Two: wind the cable into a helix and you have a superconducting solenoid—a million applications right there. Three: link some of the cables end to end and make a giant circle out in deep space. Attach a few of these in parallel and you've got the backbone for a wheel-shaped space station. Four: wrap it around a thin metal shell—hell; make it cardboard or sausage skin, for that matter—and you've got a spaceship hull. Do I need to go on?"

"No, I get the idea," Perez said, impressed in spite of himself. Clearly, the colonel had done a lot of thinking about this—much more than Perez himself had. "I capitulate; buyers will soon be breaking the door down. So why did you ask me here today, since you've apparently got all the details worked out? To rubberstamp your decision?"

Meredith snorted. "Hardly. You keep forgetting that I don't need your permission to govern Astra as I see fit." He paused, and almost grudgingly went on, "What I called you here to talk about is what we're going to do when we start making money from all this."

Perez shifted in his seat. "Carmen was talking about that some time back. She seemed to think we'd become a world of parasites."

"You disagree?"

Perez locked eyes with him. "It's been my experience that, given a choice, people prefer to work for their living. No one on any form of welfare is truly happy to be there."

"Granted. All right, then, let's assume we want all the people who emigrate from Earth to have meaningful jobs here. What will they be doing?"

"What do you mean?" Perez asked, puzzled. "They'll be doing the same sort of things people do on Earth."

"Wrong," Meredith said quietly. "Or haven't you noticed the lack of minerals and useful farmland?"

Perez stared at him for a moment . . . and then it all clicked. "Manufacturing and agriculture will be gone. Is that it?"

Meredith nodded. "There'll be some of each, but nothing like the percentages in any economy on Earth. It just doesn't make any sense to ship in raw materials to work when we can just as easily bring in finished products."

"But surely there are similar setups on Earth," Perez objected, searching his memory for a useful example. "How about—well, how about Monaco? It runs well enough with no minerals to speak of."

"Is that what you want for your huddled masses?" Meredith snorted. "To be servants and waitresses for tourists?

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Assuming we could even get tourists to come here, of course."

"No, of course not—"

"Put them all in government? Storekeeping? Selling insurance to each other? You're the one who wants to make this a paradise for the poor—tell me what they're going to do here."

"All right, the point is made." Perez got to his feet. "I agree the problem needs thought, but I'm sure we can come up with an answer. If you'll excuse me, then—"

"I'm not done yet," Meredith interrupted.

Perez considered leaving anyway, thought better of it and sat down again. "I suppose you want my word that the Council won't press for new colonists until we've sorted all this out?"

"Not really—I credit you with better sense than that. No, it's on a different matter entirely." Meredith pursed his lips. "We need to work out some kind of security arrangement with all those warships out there. Miss Olivero thought you might have some suggestions on how we might do that without creating either paranoia or animosity among whoever we send home."

Perez blinked; it was about the last thing he would have expected the colonel to ask his advice on. "I take it you don't want the whole crowd to stay up there?"

"The Rooshrike don't. They're within an ace of kicking the whole raft of them out of the system and taking over all security duties themselves."

"Not a good idea—especially after you and Carmen have been holding secret meetings with them."

"That's what I told them." Meredith nodded. "We've talked them into giving us a week to come up with a better solution."

"Hm. Well . . . perhaps a lottery drawing or something would be seen as fair—" He broke off as Meredith's phone buzzed. The colonel answered, and Perez let his eyes and mind drift out the window and up into the cloudless sky. Six alien races, all of them jockying for position to get at the Spinneret. He'd talked glibly to Carmen about playing them off against each other, but the more he thought about it the trickier it sounded. What sort of psychologies were they dealing with, for starters? Could they even assume all the aliens saw profit and loss in the same way? Surely there was overlap of some kind—they all *did* trade together, after all. But for a prize as weighty as the Spinneret any of them could easily suspend their normal business methods . . . to say nothing of their treaties or ethics—

"—wait there; do you understand? Do *not* attempt to—ah, continue until I arrive."

Perez's attention snapped back at the intensity in Meredith's voice. One glance at the colonel's expression told him instantly something was up. "Are we being attacked?" he stage-whispered.

Meredith waved irritably for silence. "I'll bring everything we'll need. You just stay put. Right." He broke the connection, punched another number. "Major Barner? Colonel Meredith. Green-seven-go; right away. Rendezvous with me west of target for directions . . . right. Out."

Meredith stood up, punching another number, and glanced at Perez. "We'll

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have to continue this conversation some other——"

"What is it?" Perez interrupted, stepping to block Meredith's path to the door.

"Dr. Hafner's team's uncovered a door in one of the hills near the Dead Sea. It may be the entrance to the Spinneret machinery." He moved his phone closer to his mouth: "Colonel Meredith. I want a flyer ready for me in fifteen minutes . . . no, thanks, I'll fly it myself. Thank you."

He dropped his arm to his side and made to go around Perez. "Let me go with you," Perez said, blocking his way again.

Meredith glared at him . . . then abruptly nodded. "All right. But stay out of our way." Sidestepping the other, he disappeared through the door.

Perez followed, lengthening his own stride to catch up. *Maybe now,* he thought, *we'll finally find out what this whole Spinneret thing was for.*

CHAPTER 17

It seemed like forever before the flyer swooped in out of the west to settle down among the low hills, but Hafner knew it had actually been less than half an hour since his call. His four-man team had made good use of the time, though, uncovering enough of the double doors to get an idea as to how big they really were. In the silence that followed the flyer's landing Hafner could hear the sound of approaching cars, and he wondered uneasily just how big a crowd Meredith was bringing. He debated heading out to the flyer to ask, decided not to waste the effort. Meredith and that pain Perez had emerged from the flyer; any questions could wait until they reached the doors.

As it turned out, everyone arrived at the same time: the two from the flyer plus six cars bursting at the seams with soldiers. "What's all this for?" Hafner demanded as the troops piled out and began taking up positions around the hill. Organizing things, Hafner saw, was Major Barner from Crosse.

"Security," Meredith said briefly, striding past the geologist and stopping in front of the doors.

Hafner joined him, trying to ignore the racket behind them. Moments like this should be celebrated with champagne, not machine gun emplacements. "We've been trying to enlarge the hole so that the doors will have room to open," he told the colonel. "You can see from that hinge over there that they swing outward."

"Um." Meredith ran his fingertips a few centimeters along the door. "Feels awfully smooth for something that's been buried this long."

"The Spinners seem to have built things to last," Perez commented, coming up behind them.

"Yeah." The colonel turned away and looked around. "Well, let's get them clear. Sergeant! Digging team, on the double!"

The caravan had come well equipped with shovels, and within two minutes a double handful of soldiers were making the dirt fly. It was relatively fast work, the crumbly ground offering little resistence, but had the doors been as tall as their five-meter combined width would have suggested, it would still have taken a good part of the day to uncover them. As it was, the doors

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proved to be just under four meters high, and the process took only an hour.

"Now what?" Perez asked when Meredith had taken as many pictures of the exposed doors as he seemed to feel was necessary.

The colonel deferred to Hafner. "Doctor? Can you suggest a way to get them open?"

"Well . . ." Hafner stepped to the hairline crack separating the twin panels and carefully prodded a raised design that spanned the doors at eye level. "This is the obvious candidate for lock or doorknob. The problem is . . . it doesn't seem to want to move in any direction."

Meredith joined him and tried it himself. "Mm. You think we've been deliberately locked out?"

"Hard to tell." Hafner stepped a few paces back and peered at the edges of the hill. "This particular mound looks like a simple case of particle accumulation—dust and sand collecting first on the lee side of an obstacle and slowly growing to cover the entire thing."

"You're saying the entrance wasn't deliberately concealed?" Perez asked.

"I don't think it was, no."

"Then chances are it's not deliberately locked, either," Perez concluded. "What do we try first: sledge hammer or dynamite?"

"Perhaps you'd prefer a small nuclear device," Hafner snapped. "It's faster and gives a much more satisfying boom."

"I wasn't suggesting we break down the doors," Perez replied mildly. "Obviously, any metal that's withstood all these years here isn't going to be bothered by a couple of blasting caps. I was thinking more of seeing if we could dislodge any sand that may have gotten into the latch mechanism."

"Oh." Hafner felt like an idiot.

"May be worth a try," Meredith grunted, squinting at the raised design. "Looks like a small crack between this thing and the doors that dust could've gone through."

"Let's try something a bit less drastic than dynamite first, though," Hafner said as the colonel started to signal one of the soldiers.

"Such as?"

"Hydrofluoric acid. We can squirt it into the crack or dribble it in from above. It should take care of any dust, and shouldn't affect the actual mechanism."

He regarded it as a small personal triumph when Meredith agreed.

It took only a few minutes for Hafner to retrieve the bottle of acid from his supplies and squirt a healthy dose of it behind the raised door design. He gave it time to get into any internal crannies, then tried the lock again. This time it moved a millimeter or so upward. More acid, and a few careful taps with a prospector's pick, and the lock abruptly came free. Hafner swiveled it a hundred eighty degrees around its left-hand door pivot point before it stuck again. . . .

And with a crunch like a steamroller on gravel, the doors slowly swung open. ■

CONTINUED IN NEXT ISSUE

● Freedom means you have to make your own choices.

Kelvin Throop

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The Alternate View

LIGHT IN REVERSE GEAR, I

John G. Cramer

The "four-wave mirror," a laser technique for reversing the motion direction of light waves so that they can be turned around and returned to their point of origin, was the subject of my last Alternate View column (*Analog*, June 1985). In this AV column I want to go one step further by examining a hypothetical kind of time-reversed light wave that should actually go *backward in time*. As we shall see, such backward waves could be used to send information from the present to the past, resulting in a sort of "poor man's" time travel. Recent science fiction novels like Jim Hogan's *Thrice in Time* and Greg Benford's *Timescape* have been based on backward-in-time communication and the situations that might arise from it. In both books a world disaster is averted by sending a message to the past. In *Timescape* a side-effect of the signaling prevents Lee Harvey Oswald from assassinating President Kennedy, irreversibly altering the course of events after 1963.

How could there be waves that move backward in time? In T. H. White's wonderful fantasy novel *The Once and Future King*, the wizard Merlin changes Wart, the young King Arthur, into an ant and sends him exploring in an ant hill. Over the entrance of the ant hill Wart comes upon a large sign which reads (in ant language) "EVERYTHING NOT FORBIDDEN IS COMPULSORY." That, as it turns out, is an excellent description of the way

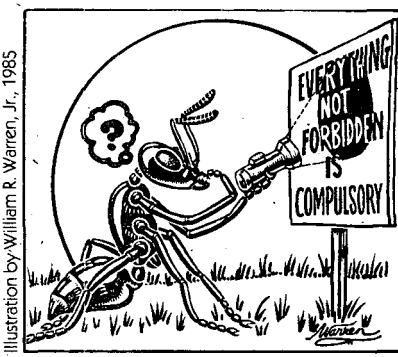

Illustration by William R. Warren, Jr., 1985

things work in ant hills.

Some of the most prominent practitioners of particle physics have been impelled by a long series of successful predictions and discoveries to adopt a similarly ant-like philosophy concerning new phenomena: "If a trusted theory describes some new phenomenon of nature and there is no sound physical reason why the phenomenon is forbidden to exist, then its existence is compulsory." The time-reversed light seems to be "compulsory" in the sense of this dictum. Yet it has never been observed.

These backward light waves are called "advanced" waves as distinguished from normal "retarded" light waves. The advanced/retarded distinction hinges on whether the light arrives at some distant place before or after it was sent. The existence of both kinds of waves is implied by Maxwell's Equations, the four amazing little equations which con-

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tain descriptions of all electric and magnetic phenomena. Maxwell's Equations can be rearranged into a "wave equation" which paints a mathematical picture of the way light works. The wave equation can be neatly solved, and one such solution (the retarded solution) describes the behavior and properties of ordinary light: it travels through space with a speed of 299.79 million meters per second, energy must be supplied to make it (so we say that it carries positive energy), and it requires a positive time to travel a given distance. For example, when ordinary "retarded" light travels one light-year it arrives one year later than it started.

However, there is also a *second* solution of the wave equation, one that is usually discarded by practicing physicists. It is the *advanced* solution. It describes a kind of light that also travels at 299.79 million meters per second but which carries *negative energy* and travels a given distance in a *negative time*. In producing such waves we would gain energy instead of losing it. An advanced-wave flashlight would charge its battery as it produced the beam. An opaque object absorbing the advanced-wave light would *lose* energy and probably become colder. And advanced-wave light would arrive at a point one light-year away a year *before* it started.

Suppose that we could make a transmitter and antenna arrangement that broadcast advanced radio waves. Since these waves carry negative energy, the production of the advanced waves would cause the apparatus to gain energy. We could connect our transmitter to the electric power grid and collect money from the light company for the electric energy we were adding to the grid. If we pointed the antenna at the Sun, we could literally "suck energy" from it, since the antenna would produce energy and the negative energy waves striking the Sun would cool it slightly, reducing its net energy by the same amount. Or we could point the antenna at empty space and not worry about how the accumulating energy debt might be paid.

When advanced-wave light travels from point A to point B it arrives at point B *earlier* than the time it left point A. Shortly after World War II, when radar was still new, a pulsed radar beam was first bounced off the Moon and reflected back to Earth. Measuring the round trip time of the radar pulse (about 2.5 seconds) became a very precise way of determining the Earth-Moon distance. If the same measurement were done with advanced radar waves, the reflection from the Moon's surface would arrive back at the Earth 2.5 seconds before the pulse was transmitted.

From there, it isn't much of a trick to lengthen the interval with automatic repeaters which bounce the advanced waves many times, lengthening the look-ahead time from seconds to minutes or hours or even days. A computer could be hooked up to broadcast ASCII-coded advance-wave messages to the past and to receive and decode them when received. Such messages could be used in any number of schemes for fun, profit, or military preparedness. The reader who is interested in possible applications is referred to Isaac Asimov's pseudo-science-fact articles in the *Astounding* magazines of the late 1940s and early 1950s concerning "thiotimoline," a kind of soluble organic crys-

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tal with the unique property that it dissolved slightly *before* water was added.

Unfortunately for time-reversed signaling, no one has ever been able to produce any advanced-wave light. It is a seemingly valid solution of Maxwell's Equations, but for some reason Nature always gives us retarded light instead. How do we know that for sure? One reason is that if negative-energy light could easily be made we should see atoms spontaneously gaining energy as they kick out advanced photons. Within convincingly low limits this never happens. Sensitive experiments have also been designed using radio telescope techniques to look directly for the effects of advanced radio waves, with negative results which set very low upper limits on their possible production. There is also experimental evidence that negative-energy advanced neutrinos and advanced gravity waves are similarly absent from our universe. Yet, according to the "EVERYTHING NOT FORBIDDEN IS COMPULSORY" dictum, if there is no physical reason why advanced waves must be absent then they should be present.

Contemporary physics does not seem to be able to tell us *why* there are no advanced waves. The best that can be done at the moment is to explain their absence by invoking the Principle of Causality. Briefly stated, causality is the principle that a cause must precede any and all of its effects in time sequence. Causality has the status of a natural law because no violation of causality has ever been observed in a physical measurement. And signaling with advanced waves could easily be used to produce a violation of the causality principle. But this argument is essentially circular: We don't see advanced waves because they would violate causality, and causality is OK because we can't make advanced waves. From this it should be clear that causality is not the *reason* that advanced waves are absent in the universe; it is only an alternative way of saying that they are absent.

This is not to say there are not theories that seek to explain the absence of advanced waves. Probably the most famous of these was originated by Nobel laureate Richard P. Feynman and his Ph.D. thesis supervisor John A. Wheeler and is called Wheeler-Feynman (W-F) absorber theory. Briefly, it asserts that advanced waves are produced on an equal basis with retarded waves, but when the retarded wave is absorbed (sometime in the future) a cancellation process takes place that erases all traces of the advanced waves and their "advanced" effects. According to the W-F theory it is always the retarded wave (not the advanced one) that is absorbed because there is always more absorption in the future than in the past due to the 2nd law of thermodynamics (see my AV column of 6/85 for a discussion of the 2nd Law). However, it has been demonstrated that this connection doesn't work in an expanding universe.

Other theories have attempted to tie the dominance of retarded-wave light to the expansion of the universe, but this approach has been shown to be invalid. I must modestly admit to being the originator of another theory which explains the dominance of retarded waves. It uses the singularity present at the Big Bang as a reflector, bouncing and cancelling

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any advanced waves which come from the future and try to penetrate it and leaving only retarded waves in the universe. In my approach light goes forward in time for the same reason that light goes forward from a spotlight: because there is a reflector behind it which bounces anything going in the wrong direction. A side effect in my reflector theory is that the universe must be open or critical (not closed) or there will be singularities in both time directions and both kinds of waves would be equally suppressed.

But such explanations notwithstanding, the physics behind our inability to make advanced waves, the so-called Electromagnetic Arrow of Time, remains one of the unsolved problems of contemporary physics. Perhaps, if we had a deeper understanding of why advanced waves cannot be made, we might arrange for an altered set of physical conditions in which they could be made. But there is a price. The principle of causality, frustrating as it is, insulates us from having to understand and solve the kind of causal-loop time travel paradoxes with which SF readers are quite familiar. But if advanced waves were to put us in the position of being Causality Busters, then our grip on reality would become more tenuous. The past could never be considered over and done with, because anyone with the proper hardware could send messages back in time and alter what had already happened. A world in which even the past cannot be depended upon to remain fixed sounds like an unstable and disorienting environment in which to live. Perhaps Nature knew what She was doing in banning advanced waves from our universe. ■

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QUESTION: "In Wheeler-Feynman absorber theory, light is emitted both into the future and into the past. How then can an absorption event in the future erase the advanced waves travelling into the past, which must have already done whatever they are going to do?"

ANSWER: The emitter makes both a retarded and an advanced wave. The absorber manages to absorb the retarded wave which hits it by making a second retarded wave which is identical to but exactly out of phase with the retarded wave from the emitter. Thus the two cancel and we say that the retarded wave from the emitter is absorbed.

However, this isn't the whole story because the absorber also must make an advanced wave. This advanced wave backtracks the retarded wave, travelling backwards in time along the path taken by the retarded wave and reaching the emitter *at the instant of emission.* It continues backward in time, but now it is accompanied by the advanced wave from the emitter and the two are exactly out of phase and equal in magnitude, so they also cancel, removing all "advanced effects" in the process. Therefore, an observer who is not privy to the inner mechanisms of nature would say that the retarded wave went from the emitter to the absorber, and that was all that happened. So the Wheeler-Feynman description, unconventional though it is, gives the same answer as the "conventional" one.

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This is nothing more than a wild speculation, of course. Or is it?

Jerry Oltion

THE BASIC UNIVERSE

Jack Gaughan

My roommate, Gene, is a computer freak. I am not. Oh, I can use a computer when the need arises, which it does fairly often for a university physics student, but my interest is not so much in machinery as in what that machinery can tell me about the way the universe works. Gene, on the other hand, couldn't care less how the universe works, so long as it does. As he once told me in a burst of witticism, he can't see the charm in quarks.

But with computers it's another matter. He can spend hours chasing bugs through a program, adding onto it here and paring a byte or two out of it there until he has it running just the way he wants it, and he's never satisfied with a commercial program until he's taken

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it apart to see how it works and modified it to meet his standards. He's had his own machine since he was in high school and he probably knows more about computers than the instructors at the university, but he needs a college degree so he takes their classes and humors them.

We get along about as well as most roommates; that is, we ignore each other most of the time. So it was that he was struggling with a program one night while I was trying to study on the other side of the room. He didn't need to struggle, but like most people who like playing with computers he had made his program tougher than he needed to in order to see just how much he could do with it. The assignment was to write a game program, any kind of game program, it didn't matter what. Anything more complex than tic-tac-toe would have satisfied the instructor, but of course Gene had to do something different. The rest of the class could turn in simple programs if they wanted to, but Gene had to try writing an arcade-style game complex enough to rival a space shuttle flight simulator, and he was finding out that he had overextended himself.

I was reading up for the next day's physics lecture, trying to soak up a little understanding of the topic on my own so I could ask a few intelligent questions and maybe make a good impression on the instructor. Dorm rooms are small; I could hear every keyclick of the terminal, every sound effect from the screen, and every curse that Gene muttered under his breath, but I'd been ignoring them all evening.

What caught my attention was the sudden silence. No cursing, no typing, no sound other than the quiet hum of the computer's fan. I looked up to see Gene staring at the screen, just staring at it without moving. I'd been living with him long enough to know what that meant.

"What's wrong?" I asked.

He looked over at me and shook his head. "Watch."

I leaned back in my chair so I could see the screen and watched him type the word "run" on the keyboard. The screen cleared and a rough representation of the Earth appeared in the center, surrounded by a pattern of moving dots.

"Satellites?" I guessed.

"Right," Gene said. He pointed to two tiny arrows, one on either side of the Earth. "This is your spaceship, and this is the Soviets', run by the computer. This thing that looks like an asterisk is a manufacturing satellite that both of you want. Maybe it's full of military hardware or something, I don't know. Doesn't matter. The object of the game is to get the satellite and land with it before the Russians do and without getting shot. You both have lasers, but you have to be careful what you shoot. You can't hit the satellite or you still lose."

"Okay," I said. "So what's wrong?"

"This." He pushed the enter key and the computer's spaceship began to move. It moved in tiny jerks, as did the satellites, as did Gene's ship when he pushed more buttons. I began to see the problem now that both ships were moving under thrust. Up till then the satellites' motion had been reasonably fast, making one orbit in about fifteen seconds, but now they slowed down tremendously and so did the ships. It took

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about thirty seconds for one orbit now.

"Not exactly a fast-paced game, is it?" I said.

"Not exactly, no."

We watched as the computer's ship crept into a higher orbit to slow down and let the satellite catch up, while Gene's ship dropped inward. As soon as the edge of the planet was out of the way the computer fired its laser, and everything slowed down still further while the shot inched across the screen.

"Looks like the speed of light is a little slow in your universe," I said.

"Just a little."

"Is there any way to make it faster?"

"Not really," Gene said. "Oh, I could take out some of the extra satellites and it would go a little faster, but not enough to make much difference. The real problem is that the program is written in BASIC, and that's just a slow language for moving graphics. I'd have to write it in machine language if I wanted it to go fast enough to be any fun."

"Why would it be faster in machine language?" I asked.

"It's just a faster language," he said. He looked over at me, obviously sizing up my vacant expression to determine how much explaining I needed, then continued. "BASIC is a high-level language; that means you can use English words to tell the computer what to do, but since the main processor doesn't understand anything but numbers, your English words have to go through an interpreter to be turned back into numbers for the processor to work with, and that takes time. Every calculation has to go through the interpreter, and this program has a lot of calculations. Machine language is written in numbers, so it addresses the processor directly and you skip a step, which speeds things up a lot. But," he said with a sigh, "machine language is tougher to write, and besides, I'm supposed to be doing this in BASIC."

"Is that why everything moves in little jerks?" I asked. "Because of its being in BASIC?"

He smiled at my naiveté. "Not completely. You can see the jerkiness worse in BASIC because it's so slow, but things move in steps even in machine language. A computer can only do one thing at a time no matter what language it's working in, so you have to move each element just a little bit at a time and do it fast enough to make it look like smooth motion."

"Like a movie," I said.

"Right."

"Or like the real universe, for that matter," I added.

"Oh?" he asked.

"That's what I was reading about just now. Everything in the universe moves in jerks, too, if you believe in quantum theory."

"Really?" Gene sounded genuinely interested in physics for once. I sized up *his* vacant expression and decided on a simplified version.

"It has to do with energy states," I said. "Energy comes in discrete packages, so for anything to gain or lose energy it has to gain or lose it in multiples of the most basic packet. That applies to potential energy too, which is what you're manipulating whenever you move something from one place to another. The jerks are so small, though, that you can't measure them."

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"How small is small?" he asked.

I consulted my physics book. There had been an example a couple pages back . . . "Yeah, here," I said. "They're using a hundred-gram mass attached to a spring that lets it bounce up and down ten times a second." I read from the example, " 'The size of the energy steps is *h* times the frequency, where *h* equals Planck's constant, or 6.63 times ten to the minus thirty-fourth Joule-se—' "

"Spare me the gory details. How big are the steps?"

I looked to the last line of the example. "Uh, it would take ten to the twenty-second discrete steps to make it move the distance of one wavelength of visible light."

Gene raised his eyebrows and nodded appreciatively. "So, no wonder the speed of light is so slow. The universal computer has to plot ten to the twenty-second number of points to move one hundred grams the distance of one wavelength."

"The universal computer?" I asked. I'd always known his world view was a little strange, but . . .

"Or God, if you'd rather." Gene laughed. "Of *course* he notices each sparrow that falls. A sparrow is about a hundred grams, isn't it? He has to plot its fall a trillion times on the way down. A trillion trillion. More!" Gene's laughter grew louder, whether at the look on my face or because of his next idea I don't know. "There's an experiment for your doctorate. Stop everything from moving for a while and see if the speed of light goes up. It should. It would cut down the processing time if there was less mass to move around."

I was glad he was so ignorant of physical principles. It gave me a handhold to use in climbing out of his insane analogy. "It doesn't work that way," I said. "According to relativity there is no such thing as absolute rest. Everything is always moving with relation to something else."

That deflated his mirth for about a tenth of a second before he said, "Well then, work it the other way. There's two ways to speed up a program. If you can't raise the speed of light by simplifying the calculations, write the whole thing in another language. One that's faster."

He looked at me, a silly grin on his face, waiting for me to answer. He had to wait a while, for I was busy thinking. He couldn't know how much sense he'd just made, because I'd never told him about simultaneity; how the speed of light determines the way we see the order of events in the universe. We can never agree that two events separated in space happen simultaneously in all frames of reference, because any information about their happening has to travel to us at the speed of light, and two observers who are moving relative to each other don't receive the light from each event at the same times. The faster the speed of light, the closer the two observers would come to agreement, but they can never agree completely unless the speed of light is infinite. The speed of light determines the simultaneity of events, but if you looked at it from the other side . . .

Suppose the simultaneity of events determined the speed of light as well? If events could happen faster, that is, more nearly simultaneously, then

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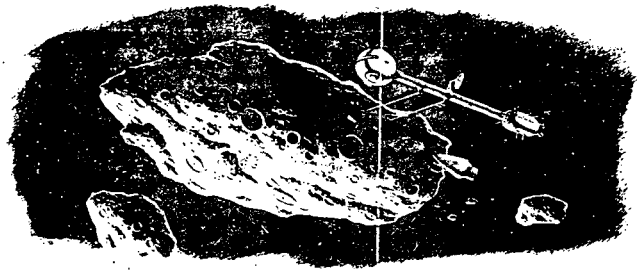
wouldn't the speed of light be faster too?

If the program could update the screen faster . . .

If we could tell God to get a move on . . .

If we could rewrite the universe to run in machine language . . .

I looked up to see Gene still laughing. He thought he had me, for of course his idea was absurd. At least for a computer freak it was. Rewrite the universe? Uh-huh. I smiled back at him. "I don't know that much about programming," I said, and turned back to my book. Inside, though, I was thinking. *But it looks like I may have to learn.* ■



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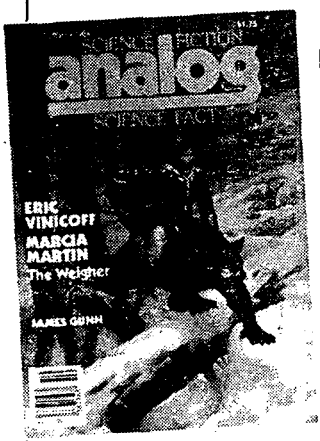

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on gaming

Dana Lombardy

What do you start with if you've never played a science fiction role-playing game or SF war game? The following list includes a dozen SF games recommended for novices, and seven fantasy titles/series for readers who also like sword and sorcery subjects.

Games marked with an asterisk (*) may be too advanced for beginners, but are suitable for people with only limited experience with SF and fantasy games.

*Battledroids** (FASA Corp.)
Robots battle each other in Earth's future. Nice plastic robot models are included with the game. Solitaire potential is good.

Cosmic Encounter (West End Games Inc.)
Each player represents an alien in this very different card game. Each alien has unique abilities that affect play. Difficult to play solitaire.

Dragonriders of Pern (Nova Game Designs Inc.)
A "picture book" game; each player has his own book (no board or cards are used to play). You must *cooperate* with the other player to destroy "thread" with your fire-breathing, flying dragon. Based on Anne McCaffrey's novels. Difficult to play solitaire.

*Dungeons & Dragons® Basic Set** (TSR Inc.)
The original heroic fantasy roleplaying game, first published in late 1974. Difficult to play solitaire.

Endless Quest Books (TSR Inc.)
Each paperback book in this series is a complete solitaire fantasy adventure, incorporating the features of role-playing. Excellent for solitaire play.

Fighting Fantasy Books (Dell/Laurel Leaf)
This series of heroic fantasy books is written for solitaire play, and the books are very good.

*Hammer's Slammers** (Mayfair Games Inc.)
SF war game about mercenary tank battles in the far future, based on the novel by David Drake. Solitaire potential is good.

*Lost Worlds Series** (Nova Game Designs Inc.)
Each book in the series is a different fantasy fighter (elf, amazon, unicorn, etc.). You "sword fight" using the book showing your *opponent's* position. Not designed for solitaire play.

Nuclear War/Nuclear Escalation (Blade/Flying Buffalo Inc.)
These two card games can be played by themselves, or joined together for one giant "nuke." Great satire, but not easily played solitaire (it's better to glow together).

Ogre (Steve Jackson Games Inc.)
In this SF war game, supertanks (including the dreaded, giant "Ogre") battle in Earth's future. Solitaire potential is good.

*Paranoia** (West End Games Inc.)
A satirical role-playing game about a

(continued on page 171)

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The slope the spacesuited runner was climbing would have been impossibly steep, even on Luna. The tracking camera relayed her image to the studio a few kilometers away. "Lovely, isn't she?" murmured Rannveig Aasen.

"She certainly is," Bill Bennett agreed. "Moving with grace on a very low gravity world is a skill few people have occasion to acquire."

As if to prove his point, the runner made a slight misstep. Instead of gliding smoothly forward, she bounced a good five meters up off the ground. She had the presence of mind to hold her pose for the eleven seconds it took for her to return.

"That could happen to anyone," Bennett said sympathetically. "Mimas's surface gravity is only .008-g. To put that in perspective for you folks back home, Luna pulls more than twenty times as strongly." The transmitter flung his words and picture across one and a third billion kilometers toward Earth. At light speed, they would reach perhaps that many sets an hour and a half later, with the slightly misleading legend "Live—from Saturn" superimposed.

The girl reached the summit without further mishap. She paused for a moment before the large bronze bowl there, then reached up and thrust the rod she carried in her right hand over the edge of the cauldron. A great sheet of yellow-orange flame, twice as tall as a man, sprang into being.

"It's a hologram, of course," Rannveig said, "the same principle that makes stereovision possible. Mimas is almost nothing but ice, and has no atmosphere at all. But it still makes me

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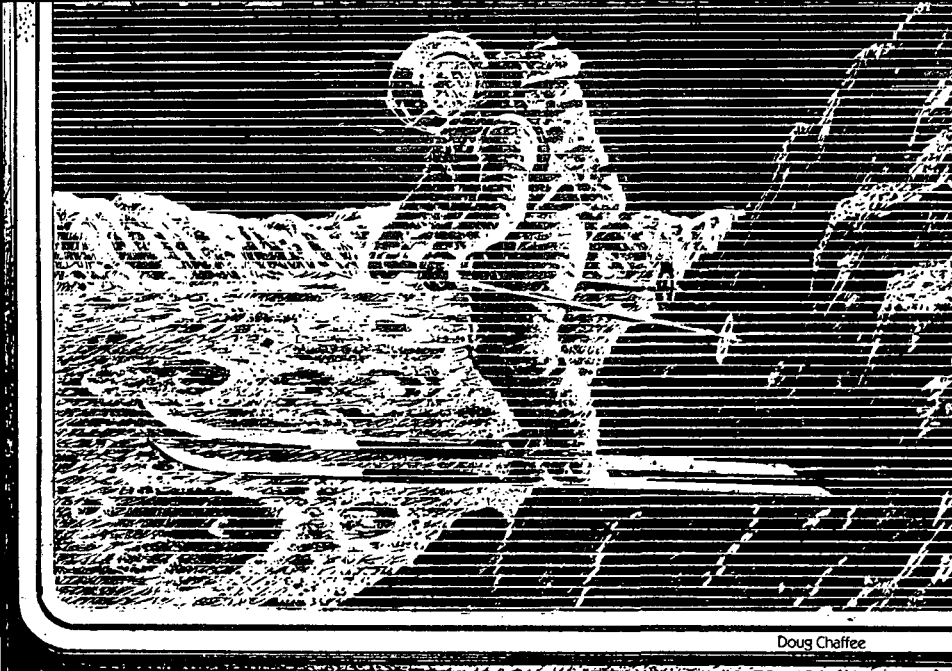

Doug Chaffee

Eric G. Iverson

Expanding to other worlds will naturally open up exotic new possibilities for athletic competition—among other things.

LES MORTES D'ARTHUR

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want to reach out and warm my hands over it."

"Me too," Bennett said. "We'll return to our coverage of the sixty-sixth Winter Olympic Games in a moment, but first these words." Bennett disappeared from the monitor screen, to be replaced by the Interplanetary Broadcasting Company's keynote symbol for this part of the Games: an ancient black-and-white Voyager image of Mimas, with the great crater Arthur dramatically shadowed near the terminator.

When the commercial break was done, the camera cut away from the broadcasters to the icy plain at the foot of Arthur's central peak for the opening parade of athletes. Bright blue eyes twinkling, Rannveig Aasen undid the belt that held her in her chair, pushed off, and caromed round the studio like an insane billiard ball with a cometary tail of long blond hair.

The director howled curses into her earphone, but she always managed to keep an eye on the monitor and did not miss a beat in her commentary. "The two men and two women at the head of the procession, the ones in the light-blue and white spacesuits, are the Greek contingent," she explained for her distant audience. "Greece has been part of United Europe for more than a hundred fifty years now, but still fields an independent team at every Olympic Games, in keeping with its place of honor as the homeland of the Olympic ideal."

Bennett listened to her with nothing but admiration, a word also describing his feelings as he watched: the female form does not sag at all in .008-g.

The terrestrial portion of the Winter Games was being held at Klagenfurt in United Europe this year, so the athletes crossed the ice in their national groups in French alphabetical order. That put the United States—or rather, États-Unis—near the front, just after the Chinese Empire, instead of toward the end.

"This is the first time in four Olympiads that the Americans have sent a team—if I can call one man and one woman a team—to Mimas," Bennett remarked. "They haven't had much low-g training and aren't expected to contend for medals, but it's good to see them competing here again. Private contributions raised enough money for two berths aboard the Arab World ship *Nasser*."

Several larger groupings passed —Eastern Europe, the Anzac Federation, Japan, Luna. The team from the Arab World looked smart in spacesuits of green, white, and black. "Security is tight here," Bennett said, "thanks to threats from Israeli, Turkish, and Armenian nationalists."

Moscow fielded a strong group. So did Siberia. There were a couple of Swiss athletes, in red suits with white crosses. They had traveled with the United Europeans in the same way the Americans had with the Arabs. United Europe, as host nation, came last, just behind the contingent from Zaire.

Rannveig was finally back in her seat. "Personally," she said, "I think the United European uniforms are busy."

"So do I," Bennett nodded. "But then, they almost have to be, since they're blending so many sets of former national colors. Some of the rivalries that went with those old colors aren't dead yet, either, and the newer one be-

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tween United Europe and Eastern Europe is also no laughing matter, I'm afraid. You Europeans are a contentious lot," he said to Rannveig, who came from Oslo.

"No, we're not," she replied in mock anger.

"You certainly are."

They pythoned it back and forth for another minute or two before Rannveig started the wrapup of opening-day coverage, remarking, "Our viewers may be wondering why only a relative handful of teams are represented here, as compared to Klagenfurt."

"Cost is the villain," Bennett said. "Fares from Earth to the Saturn system still run over 1,500 ounces of gold. That's one of the major reasons we've seen so little from the United States in recent years, for example. If spaceflight were cheaper, we'd see many more nations participating."

"Something to look forward to, perhaps, in Games to come." Rannveig closed out: "Thanks for joining us for the opening ceremonies from the Mimas Winter Olympic venue. Tomorrow we'll be bringing you first-round coverage of the most spectacular of all Olympic events, the five-kilometer ski jump —program your sets to 'Olympics' now, so you won't miss a moment of the action. See you then."

The old Voyager picture of Mimas reappeared on the monitor. This time, though, a bright red line superimposed on the image showed the ski-jump track descending from the summit of Arthur's central peak—the largest athletic arena in the solar system. Ten kilometers away, a red oval showed the landing area.

"That went off very well," the director said, adding, "all things considered," with a pointed glower Rannveig's way. She paid no attention, leaning back in her chair to let a makeup man scrub her face clean.

Bennett did the same, enjoying the damp sponge on his forehead, cheeks, and chin. He was very little changed when the ministrations were over: an open-faced, light brown man in his early thirties; burnsides, popular after a lapse of fifty years, looked good on him.

So did his engaging smile, even if it was a touch smug at the moment. He had a right to feel self-satisfied. IBC did not hire many Americans; most were too parochial to do well outside their own small bailiwick, and few spoke anything but English or Spanish. But his French, once again the dominant international tongue, was as fluent as any native speaker's; to his own way of thinking, at least, he had a better accent than Rannveig did.

"Care for a drink?" he asked, and she gave an eager nod.

They swung hand over hand from rings set in the hallway ceiling toward the bar. Brachiating was the easiest way to get around on Mimas; the gravity was really too weak for walking, especially indoors, but just enough to make free fall-style gliding impractical too. "I wonder why we ever came out of the trees," Rannveig said, darting ahead.

The studio was part of the same complex that housed the Olympic athletes. The two broadcasters sped past pressure doors and spacesuits in niches: like any structure exposed to vacuum, the Olympic village was divided into hundreds of gastight segments. The front door to

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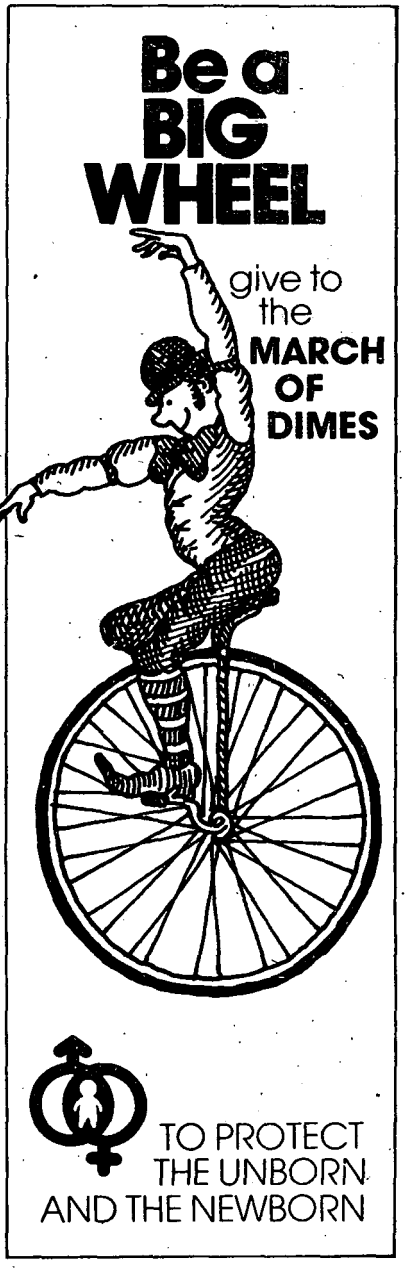

every suite was a bulkhead in its own right.

Once she had hooked her feet under the brass rail, Rannveig ordered aquavit with a beer chaser. Bennett chose rum and Coke; since the rediscovery of the original formula in the ruins of Atlanta, Coca-Cola was all the rage again.

The drinks came in squeezebulbs with nipples, as they would have in free fall. An incautious lift would have sent the contents of glasses flying.

The monorail shuttle returned to the Olympic complex from the parade ground. Athletes and coaches began drifting into the bar. Most of the competitors, knowing they would have to be at their best tomorrow, were moderate. Their mentors had fewer compunctions. The Muscovite coach, in a red and gold sweater, and his Siberian counterpart, who wore his team's snowy white, challenged each other to a duel of vodka. Empty squeezebulbs accumulated in epic numbers around them.

The two of them argued, more or less amiably, as they drank. The Muscovite spat Slavic consonants at his opposite number. The Siberian replied in French, letting Bennett follow his half of the conversation. For a Czarist nobleman, Russian was fit only for talking with servants, infants, and pets.

"It seems hardly fair for peasant upstarts to have better accommodations than we do," he said.

The Muscovite coach answered. The Siberian rolled his eyes. " 'All quarters are equal,' indeed. *Merde*—why has the Olympic committee placed us where we cannot even see the competition area?"

No one could see the competition area; the window in the bar was the only

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one in the Olympic village. The Muscovite must have pointed that out, because the Siberian said, "It is the principle of the thing, though principle, I suppose, is something a Marxist cannot be expected to understand."

The Muscovite's only comment to that was a belch. He fell asleep a few minutes later. His counterpart's triumphant smile also quickly dissolved in snores.

Except for one Jew, the members of the Arab World's team were teetotalers. They sipped fruit juice and passed a pipe back and forth.

A ski-jumper was turning cartwheels in midair. Rannveig touched Bennett's hand. "Look at the Loonie showing off."

"You can hardly blame her. This is the only place were she can compete against Earthpeople on even terms —Mimas makes everyone strong." He finished his drink. "Do you mind if I drift around a bit?"

"Heavens, no. Have a good time. I certainly intend to." She looked at him archly. "Don't do anything I wouldn't enjoy."

He grinned. "That doesn't leave much out." They had ended up in bed a couple of times during the trip to Mimas, more out of boredom and simple propinquity than anything else. It had been fun, but nothing on which to build a grand passion.

The ski-jumper from Luna landed on her head, laughing. "Was that half a turn too many, or too few?" Bennett asked her.

"I sort of lost track up there," she said. She looked at him curiously, trying to place him. Most of the athletes were still in the tight pullovers and hose they had worn under their spacesuits, which made his conservative green-velvet doublet, tunic, and paisley neckscarf stand out by comparison. "I know!" she exclaimed after a moment. "You're from IBC!"

He admitted it. She insisted on buying him a drink. Not much happened in the controlled environment of Luna, so stereovision was even more popular there than it was on Earth. "I'm just a media addict," she said.

"Nonsense," he said gallantly. "How could you get into that kind of shape sitting in front of a set all the time?" He bought the next round himself, and the one after that; he was sure his expense account was stretchier than hers.

He glanced over and saw Rannveig deep in conversation with a big man as blond as she was. Another Scandinavian, was his first thought, but then he noticed the fellow was wearing the eye-searing blue, red, and green of Eastern Europe. They did not seem to be having any problems getting along, though.

Nor was he, with the girl he had met. A promising evening all the way around, he thought.

"And now," Rannveig said, "I'd like to introduce our expert analyst, Angus Cavendish, bronze medalist for United Europe in the five-kilometer ski jump in the 2192 Winter Games."

"I thank ye very much," Cavendish said. He was a small, dapper man in his early forties, just beginning to gray at the temples and on his cheeks. The Scots burr with which he flavored his French should has given his voice an air of impressive deliberation. It probably

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would have, too, if he spoke a little slower, but he was too excitable for that. He always reminded Bennett of a tape recorded at eight centimeters a second and played back at sixteen.

"Tell us, Angus, what's the most difficult thing about this event?" Bennett asked. He had the slightly too good feeling hangover pills always brought.

"The training for it," Cavendish said at once. "For where d'ye find the like conditions in the inner solar system? It's only the right countries can afford to ship their skiers out here for the sake o' the exercise: the Arab World, Luna, Japan, Siberia."

"Then how do you account for your own medal?" Rannveig asked.

"Me, lass? I was assistant engineer on a supply ship to the Mimas Saturn station and borrowed my skis from a computer tech there. You look down the rosters of the teams and you'll find a great lot of spacers among 'em. We're the ones who come to Mimas on our own business and learn a bit while we're here."

Following the script they had roughed out, Bennett said, "Why don't athletes from nations that can't afford to send them here train on the moons of Mars? Those have an even lower surface gravity than Mimas."

"So they do, but they don't have Arthur; they're too puny. Look here, now." The screen behind the broadcasters displayed the trademark image of Mimas. Cavendish used a pointer. "The crater is a hundred thirty kilometers across and ten deep, with the central peak six kilometers high. The body that struck Mimas to make it must have been ten kilometers across (almost the size of Deimos, mind); if it had been any bigger, it would've cracked the moon apart."

"From what you've told us, then, I take it the technique for jumping on Mimas is quite different from the one skiers use back on Earth," Rannveig said.

"Exactly so. That's why not all skiers can make the transition from one to the other. Let's watch the monitor again, if we can."

The screen showed the ninety-meter jump at Klagenfurt. A skier appeared at the top of the slope, pushed off, and went into her tuck. "There's the first difference already!" Cavendish cried. "You can't simply tuck and run here, or you're done for in the jump. At .008-g, you see, you don't build up the velocity even in five kilometers that you do in the ninety meters on Earth. You have to use poles all the way down."

"But there are risks in that too, aren't there?" Bennett asked.

"That there are. In the low gravity, each push sends you up off the slope. The more you bounce about, y'see, the less time there is to be pushing. You have to dig in at just the right angle to come down again quick as you can. If you've done it right, you spring off at the end with about the same speed as off the ninety-meter hill back home—near a hundred kilometers an hour."

As if on cue, the jumper in the monitor screen launched herself into space. "With the local gravity so low, you'd think you'd almost be able to jump clean off Mimas," Rannveig said.

"'Tisn't so," Cavendish snorted. "The escape velocity's over a hundred seventy meters a second; you scarcely

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reach the sixth part of that. Nay, with the ramp angled up at forty-five degrees, you take about four minutes to sail up two and a half-kilometers—three and a half over the floor of Arthur. Then it's down again. Overall, you're flying between nine and ten minutes."

"It must be a marvelous view," Bennett said.

"That it is." The line was planned, but Cavendish's eyes went genuinely misty. "You think you can see forever; in fact, it's about thirty-five kilometers."

The screen behind the Scotsman showed the jumbled vista of the crater floor. Small pits and mounds of ice began lazily flowing out of the picture at the edges; what remained grew larger and larger. "Of course, eventually you have to think about landing," Bennett said.

"So you do," Cavendish said dryly. "There's the rub. You hit the slope at more than a hundred and ten kilometers an hour, and you don't dare tumble. They have subsurface pipes to heat—if that's the word I want—the landing zone a hundered degrees or so, up to −30° C, same as the runway. Still, rip your suit and you're gone. Almost every Games, it seems, they add a name or two to the memorial plaque at the peak of Arthur."

"Is it worth it, then?" Bennett asked. That line was in the script, too, but he meant it. Risking one's life unnecessarily struck him as insane.

Cavendish's reply caught him by surprise. It came from the man, not the color commentator: "Lad, for the feeling you get when you're up there, why, dying'd be a small price to pay."

There was a moment of dead air before Rannveig took up the slack, saying quietly, "All the athletes here today would agree with you, Angus."

The broadcast going back to Earth cut away from the studio to the pressurized lodge at the top of the runway. Like the Olympic village complex below, it rested on pylons sunk in the ice. The camera focused on the airlock door, which opened to let out the first contestant.

She wore the deep blue of the Anzac Federation; her clear faceplate showed intense concentration on her features. "This is Marge Olbert," Rannveig said. "She's twenty-six, from Canberra, a junior ecology officer aboard the *Wirraway*, one of the Anzac Line's asteroid-belt freighters."

"Ah, then she'll have some work at very low gravity," Cavendish said. "A plus for her."

The starting light went from red to green. Marge Olbert dug her poles into the ice. "A good pushoff!" Cavendish cried. "See, she's still low enough to take a second shove. That's the way to do it—keep the polework as near parallel to the runway as you can!"

The skijumper landed, pushed, flew; landed, pushed, flew. Each thrust of the skipoles added to her velocity; so, little by little, did Mimas's weak pull. "Oh, excellent form—she'll be close to that hundred kilometer an hour mark," Cavendish said.

Marge Olbert was rocketing down the slope now. "A shame we're in vacuum," Bennett said. "The wind shrieking by Ms. Olbert would give the audience an added sense of her speed."

Cavendish chuckled. "They can tell she's going fast, never fear."

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She used her poles powerfully on the short upslope at the end of the run, gave a last great spring, and launched herself into the void. Red numbers appeared on the monitor: 97.43.

"A splendid takeoff velocity," Cavendish said. He unobtrusively checked a chart he was holding in his lap. "She'll be out past ten and a quarter kilometers. The women's record's only 10.6. Could well be the longest women's jump of the first day. She'll give the other lassies something to think on."

The flick of a switch brought the transmission from Olbert's suit radio into the studio. "Oh, my," she was saying again and again. "Oh, my." A reminiscent grin spread over Cavendish's face.

Marge Olbert was soaring up toward her maximum altitude when coverage cut back to the slope, where another jumper had already begun his run. "They'll be going about every five minutes," Bennett explained, "so one will be landing, another just past high point, and a third jumping at about the same time."

"That's right, Bill," Rannveig said. "On the runway now is Josef Jablonski of Eastern Europe." Bennett wondered at the sudden warmth in her voice until a closeup showed the face of the man she had been with the night before. She went on, "He's twenty-nine, an air force captain from Gdynia; his hobbies include basketball, chess, and wargaming."

Not all of that was on Jablonski's personal data sheet. Bennet smiled a little.

"He's a strong-looking brute," Cavendish said. Rannveig jerked her head, whether in agreement or indignation Bennett could not tell. The Scotsman carried the narration: "Good form into the upslope—aye, a mighty push there, and now the leap . . . 101.74 kilometers an hour! A fine first jump; it'll go well past eleven kilometers."

A tight telephoto showed the expression of almost religious awe that Jablonski was wearing as he sailed high over the frozen surface of Mimas. "With a shot like that, you don't need words," Cavendish murmured.

The monitor split into thirds, simultaneously tracking Marge Olbert hurtling down toward her landing, Jablonski nearing apogee, and the next contestant on the runway, a Siberian woman who crossed herself before she began her descent.

Dream-smooth, the girl from the Anzac Federation touched down, steadying herself with her skipoles. "Here's her distance now," Cavendish said. "It's 10.290 meters—a splendid opening jump." As Marge Olbert killed her momentum on the reverse slope beyond the landing zone, a crawler came out to pick her up and take her back to the Olympic village. Her raised fist said she knew what she had done.

Then Josef Jablonski was landing, not as gracefully as his predecessor, but safe enough. Red numbers superimposed on his image gave the length of his jump: 11.149 meters. "Astonishing that only a four kilometer-an-hour difference in takeoff velocity will produce so much extra distance," Rannveig said. She did not sound astonished; she sounded proud.

"It's enough to send Jablonski over two hundred meters higher than Marge

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Olbert, and keep him over the ice twenty seconds longer," Bennett said, echoing the quick calculations one of the technical people was feeding into his earphone.

One after another, the jumpers flew through their parabolas. With sixty-eight competitors in all, the first round was scheduled to last nearly six hours. As Cavendish had guessed, Marge Olbert's distance kept holding up, though the girl from the United States, making her first jump ever off Earth, startled everyone by coming within seventeen meters of it. On the men's side, Josef Jablonski stayed in solid contention, if not among the very leaders.

They were down to the last half dozen competitors when Bennett remarked, "So far we've had one of the safest first days ever for the Mimas venue—only a couple of minor spills, and no serious injuries. What do you think accounts for our good fortune, Angus?"

"Nothing but luck, so far," Cavendish said. "If we're as well off after all three days of jumping are done, then we'll have something to brag about."

The dismissal irritated Bennett, but at that moment another jumper soared off the ramp. His annoyance instantly turned to excitement. "Look at that!" he exclaimed. "We'll have a new leader if Shukri al-Kuwatly lands safely!"

"He was a favorite, aye," Cavendish said, "but who would've thought he'd have a takeoff velocity of 103.81 kilometers an hour? That comes to a jump of over 11,580 meters, enough to put him in front by more than forty meters. Watching his form, I own I didn't think he'd be off so strong."

Back at the top of the runway, a Muscovite in red and gold waited for the starting light. Rannveig said, "It has to be disheartening for Dmitri Sheplov to stand up there, knowing what his predecessor has just done."

"I suspect he's been through worse," Bennett commented, reading from Shepilov's data sheet. "He comes from a Guards Regiment of Muscovite ski troops, and he saw combat against the Siberians in the Ural skirmishes a couple of years ago. After that, a ski jump should be small potatoes."

"I wonder," Angus Cavendish said with a grin. "Then it was only the eye of his sergeant on him, not the whole of Earth and Luna."

Shepilov's speed down the ramp was slower than al-Kuwatly's at every checkpoint, but still respectable. He launched himself at just over a hundred kilometers an hour, a jump which projected out close to an even eleven kilometers.

Coverage of the next athlete, a man from United Europe, was brief; attention switched away to al-Kuwatly, who was heading down toward his landing. "I don't look for any trouble from him," Cavendish said. "He's still half a kilometer up, almost two minutes away from putting his skis to the ice, but already he's in good position, as he should be. Nothing'll go wrong here."

The slow-motion shots of what happened next would be replayed endlessly. Seeing everything live, Bennett was chiefly conscious of how fast sportscasting banality turned to horror. He had actually been laughing at Cavendish, for no sooner were the Scotsman's words out of his mouth than they all watched

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al-Kuwatly's hands open and his ski-poles drift away.

Everyone in the studio started in consternation at the sudden misty globe around al-Kuwatly's head, the rime forming on his faceplate and the sides of his helmet. "His suit's failed!" Rannveig cried, a split second ahead of Bennett and Cavendish.

The could do nothing but watch. Had it been he up there, Bennett knew he would have been thrashing wildly, clawing at his helmet to try somehow to maintain the pressure. But the jumper from the Arab World held the posture he had been in at the moment of disaster. Only very slowly did his bent arms begin to straighten and slump to his sides.

As a veteran spacer, Cavendish was the first to recognize what that meant. "Murder!" he shouted. "That's a killed man up there, else he'd be making shift to save himself." He might have been reading Bennett's mind, but he generalized where the younger broadcaster had not.

Al-Kuwatly's flight path did not, could not change. Trailing vapor, he plunged toward the landing slope. He hit the ice like a thrown cloth doll, bounced and tumbled bonelessly. If he had not been dead already, the impact would have killed him.

Sickened, Bennett turned away from the big monitor screen behind the broadcasters. As a result, he was the only one of them looking at the bank of screens to one side that showed what all the active cameras were picking up. He saw Dmitri Sheplov raise his right arm; it looked as though the Muscovite was starting to point. Then vapor spouted from his helmet too. "Sheplov's hit!" he cried.

No one had paid any attention to Louis-Philippe Guizot, the jumper who came after the Muscovite. Perhaps because he was from United Europe, Bennett's yell made Rannveig check another of the side screens for his safety. Guizot was only a few hundred meters from the takeoff ramp when his image was also shrouded by fog. "Oh, no!" Rannveig cried, and covered her face with her hands.

Bennett learned to hate Mimas's low gravity. Sheplov had been near the apex of his jump when he was hit; he flew on, a corpse, for five dreadful minutes before crashing on the landing-slope as al-Kuwatly had before him. It was even worse with Louis-Philippe Guizot. Propelled by the leap he had taken before the assassin struck, he soared above Mimas as if still alive, then spun down in hideously lazy descent.

"This is madness!" Bennett said. "Who but a madman could think to mar the Olympic Games with violence? Even in wartorn ancient Greece, the Olympic truce held good; the modern Games have been the victim of attack only twice, and the last time was more than a hundred years ago."

The director spoke in his ear. His voice went hard as he relayed the news to his distant audience: "We have just received a radio transmission claiming responsibility for the atrocity that has taken place here today. Here is a recording of that transmission."

The tape was scratchy; the transmitter must have been a tiny one, and Saturn's radio emission chopped up the signal. But it was perfectly understandable.

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"As it is the Olympic language this year, I shall speak French," a man's voice said. It had a faint guttural accent, and was full of irony and a good humor that chilled Bennett. "Shukri al-Kuwatly was but the beginning. We of the Second Irgun vow to continue our war against Arab tyranny until the Star of David once more flies above Israel. We regret the need to harm others, but those who share pleasures with oppressors must also share their fate. A very good day to you all."

The voice cut off, leaving behind only the impersonal hisses and pops of background noise.

The director cued Bennett through the earphone: "Three, two, one—all right, you're on." The light above the camera lens turned red.

"Welcome once again to the Mimas venue of the sixty-sixth Winter Games," he said. "Competition, of course, has been suspended after yesterday's tragic events. When and if it will resume remains unknown—that largely depends on whether the cold-blooded killer who so callously took the lives of three athletes can be detected and apprehended. For any of you who may not have been with us yesterday, here is Rannveig Aasen with a review of what took place."

"Thank you, Bill," she said gravely. She summarized the previous day's jumps. Behind her, the big monitor screen reran in quick succession the deaths of al-Kuwatly, Sheplov, and Guizot. Rannveig said, "Examination of the bodies has shown that each of the three athletes was murdered by a burst from a high-powered laser weapon. They were killed instantly; none, of course, had any chance to defend himself."

"How could such a thing happen?" Bennett said. "As we noted before, security is supposed to have been tight. With us now is Major Katayama Hitoshi, head of Mimas Security. Come join us, Major Katayama."

Moving smoothly in the low gravity, the Security chief came over and sat down by the two broadcasters, strapped himself in. "Thank you for being with us at this difficult time. Tell me, if you will, where did your precautions break down?"

Katayama grimaced, not caring for the blunt question. He was a stout, hard-faced man with iron-gray hair. After a moment's thought, he said, "I am afraid this will seem self-serving, but much of the failure took place on Earth, when a killer was allowed to board ship for Mimas. Once that happened, his or her success was probably inevitable."

"How can you say that?" Rannveig challenged. "Surely you searched everyone's baggage for arms of all sorts. I know mine was opened, and Bill's too."

"Yes, that is so," Katayama said. He spoke slowly; he was very tired, but still picking his words with care. "Explosive guns and missile weapons are easy to detect. With lasers, sadly, the same is not the case. Laser tubes are too ubiquitous. They are at the heart of your stereovision equipment, of still-picture holocameras, of computers' scanning devices, and in dozens of other everyday tools. Skilled terrorists find it all too simple to improvise deadly weapons. It is an unfortunate fact of life."

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"Even so," Rannveig persisted, "why didn't your force of guards keep the assassin from reaching cover, or track him down after he did his work?"

"Let me point something out, Ms. Aasen," Katayama said coolly. Rannveig bridled, but he went on before she could interrupt: "I have twenty men here. As your colleague Mr. Cavendish Angus pointed out on an earlier broadcast, at the peak of a jump an athlete can see for thirty-five kilometers—which means he can be seen and shot at from that distance. The area of a circle with a radius of thirty-five kilometers is more than 3,800 square kilometers, or about 190 square kilometers per guard. I hope you see my difficulty."

Off-camera, Bennett winced. Katayama was not an easy man to shake. The broadcaster had no intention of giving up without a fight, though. He asked, "Have you had any luck with photos from the observation satellite in synchronous orbit above Arthur?"

"A very intelligent question, sir," the Security chief nodded. "Unfortunately, the answer is no. We were in dark phase at the time of the attack, with the only light outside the area of competition coming from Saturn's other moons. They are either small or distant or both, and in any case receive only a bit more than one percent of the sunlight per unit area that Luna does. And exactly because it is in synchronous orbit, the satellite is over six hundred kilometers above us. Perhaps computer processing of its images will show more. That is our best hope, I think."

Bennett gave up. Katayama seemed to have all the answers, and a depressing lot they were. Rannveig, however, was still smarting from the rebuff she had taken. She said, "Forgive me for one last question. Why didn't any of your guards spot the flash of the laser when it was fired?"

The Security chief's smile was like a shark's. "In vacuum, of course, there is no flash," he said, as if to a foolish child. "We only see beams of light because they shine through dust and vapor floating in air. I wish it were otherwise, but it is not."

"Thank you, Major Katayama," Bennett said quickly. "We'll be back with more after these messages."

As the commercials began, Katayama departed, looking pleased with himself. Rannveig shook her head in disgust. "Well, he put me away, didn't he? That's what I get for forgetting my homework."

Bennett touched her hand. "Don't worry about it. It's the same question almost everybody on Earth would have been asking himself."

"Do you think so?" she said doubtfully, but she looked a little happier.

When they returned to the air, they replayed the tape claiming responsibility for the attack. "For the reaction of the Second Irgun, IBC correspondent Jorge Martinez visited the group's headquarters in Buenos Aires," Bennett said. "Here is his report."

The tape filled the monitor screen. Along with a flock of other reporters, Martinez was standing in front of a gray stone building in a rundown part of the city. Out came a slight, curly-haired man with a mustache too big for his face and fierce, ever-watchful eyes. "The Second Irgun's spokesman is known

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only as 'Menachem,' " Martinez said quietly.

They watched "Menachem" begin to read from a card he pulled out of his hip pocket: "We applaud the blow against the Arabs who have stolen our homeland from us, but we did not strike it. That is all we have to say."

"What proof do you have for your denial?" one of the reporters shouted.

"Menachem" fixed him with an icy glare. "I have said, that is all we have to say." Then, with the air of a man making a great concession, he went on, "Had it been us, we would have chosen Itzhak Zalman, the *apikoros* who loves his masters better than his people and joined the Arab team. His time may yet come, if not on Mimas, then when he returns." He went back into the headquarters building, slamming the door behind him.

"Not the most convincing denial on record," Rannveig commented.

"Hardly," Bennett said. "The only thing to say in its behalf is that the Second Irgun is not in the habit of ducking the blame for its terrorist acts. The notorious Baghdad bombings of a few years ago are a case in point."

"If not the Second Irgun, though, who benefits from the killings? Savage as they were, they have succeeded in embarrassing the Arab World, thanks to the disclosure of Shukri al-Kuwatly's illegal suit."

"There you're right, Rannveig," Bennett said. "Cheating is almost as old as the Olympics, I'm afraid; drug use and such things as electronically rigged fencing foils go back to the twentieth century. Al-Kuwatly's suit is just the latest in a long line, and one of the more ingenious. It was discovered to have a gas vent opening in the small of his back—in effect, a small reaction motor to add to his speed down the runway. With a surface gravity as low as Mimas's, even a few extra centimeters per second could have been decisive."

"Yes; al-Kuwatly would have been the leader at the end of the first day of competition," Rannveig said.

"In the rash of speculation surrounding him, however, we shouldn't lose sight of the other two athletes who were slain. Our sincerest condolences go to the families and friends of Dmitri Sheplov and Louis-Philippe Guizot, who also fell victim in this savage attack."

"As happens all too often in acts of terrorism, it is the innocent who suffer," Rannveig agreed. "That's true not only of the men who died yesterday, but also, in a lesser way, of all the athletes who came to Mimas in hopes of victory and instead find themselves encompassed by tragedy. For the competitors' reaction to yesterday's events, let's go to Angus Cavendish."

"Thank you, Rannveig." The Scotsman was sitting at the Olympic village bar. "With me here is Itzhak Zalman, the Arab World jumper who, as you heard, has been threatened by the Second Irgun." Also with them, unmentioned but plainly visible, was one of Major Katayama's Security guards, a sidearm on her hip. Cavendish said, "Tell me, Itzhak, what are your thoughts on the menacing statement read by 'Menachem'?"

Zalman, ironically, looked rather like a younger version of the terrorist leader, but his face was more open, calmer. He spread his hands. "I'd sooner accept the

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present as it is than live in the dead past. I've been threatened before. You can't let it worry you, or it'll affect your performance."

"Spoken like a true competitor," Cavendish said. "Let me ask this, then: how do you feel about what your teammate al-Kuwatly had done to his suit?"

"He was a fool." Zalman said flatly. "I knew nothing about that, and I can still hardly believe it. My own jumping suit conforms to every standard. What good is a medal you've cheated to win?"

"Aye, that's a poser, though there's some who don't care, I'm sorry to say. Am I right in thinking you're doing your best to stay in condition during the delay in the jumping?"

"Oh, of course. I can't go out on the ramp, naturally, but I'm doing both stretching and weight work. The weight rooms have been packed."

"What's the atmosphere there?"

"About what you'd expect—nervous. After all, none of us knows whether the person working out beside him is a killer." Zalman thought for a moment, amended his last statement: "No—*one* of us does."

"You've put your finger on the true calamity of these Games," Cavendish said. "Olympics may have been disrupted before this, but never by people connected with them. Thanks for joining us, Itzhak, and best of luck when the competition resumes."

Zalman nodded soberly. "I will take all the luck I can find, thank you. Being who I am, I need it." He bounced away.

Cavendish said, "We'd hoped to have a member of the team from Moscow with us, but they've all declined to speak on camera. Joining us instead is Nikolai Yezhov of Siberia. Welcome, and thank you for being with us today."

"My pleasure." Yezhov's French had less of an accent than Cavendish's. Short, stocky, and solid, he looked formidable in his spotless white tunic with the cross of St. George on an embroidered patch on his left shoulder.

"Did you know Sheplov well?" Cavendish asked.

"Not very, I'm afraid." Aristocratic contempt showed briefly in the Siberian's eyes. "The Muscovites always stick close to themselves. Not cultured."

"Er, yes." Cavendish changed the subject in a hurry; from a Russian-speaker, "not cultured" was the kind of insult that started fights. The Scotsman said, "What reaction have ye noticed among the athletes to word of al-Kuwatly's suit?"

Yezhov's smile seemed genuinely amused. "The only sin is to be found out, is it not?"

Every question Cavendish asked was getting him into trouble. Gamely, he tried again, after a glance at Yezhov's fact sheet: "This is your first time off Earth, nay?"

"Oh, certainly. I was a simple stereovision installer in Kolyma, by the Sea of Okhotsk, a weekend skier, I think the saying is, when the Little Father honored me by including me on this year's team."

"Aye, just as ye say, 'a weekend skier.' " Cavendish finally let himself smile; the Czar's recruiting and training methods were notoriously effective, and started at about age six. "A coincidence, then, that you took the Siberian

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downhill championship four years ago and have held it ever since?"

Yezhov's expression was bland. "Yes, as a matter of fact, or at least my first win. The favored skier broke his leg in a fall, opening the door for me."

"How lucky for you." Cavendish sighed. Despite his best efforts, Yezhov remained opaque. He might claim greater sophistication than his Muscovite counterparts, but he was no more forthcoming. Cavendish thanked him again for appearing, then passed the show back to the studio with obvious relief.

Rannveig handled the signoff. "We'll be returning you to your regular programming now," she said. "Stay tuned to this station for developments as they break. When and if competition resumes, of course, you'll see all of it here." The monitor cut to a commercial.

Glancing at it, Bennett said, "Meanwhile, our advertisers are out slitting throats because they just lost five hours of guaranteed high ratings."

"I wish Katayama had said more," Rannveig said, adding with a curl of her lip, "He was so busy pointing out how none of this was his fault that I think he hardly cares whether he ever catches up with the killer."

"If his precious satellite didn't show him anything, he's got damn all to go on," Bennett said. "No wonder he's asked for copies of our tapes." He paused. "I wonder . . . think back to Sheplov. Didn't it seem to you that he'd spotted something in that split second before the laser got him?"

"What if he did? Our job is to report, not to investigate."

"There's still a bit of a different tradition left in the United States. I've never had much of a chance to go ferreting things out, but I think it would be interesting to try."

She shrugged. "If your idea of fun is trying to do the same thing as the professionals are doing, don't let me stop you. But I expect I'll have a better time with Jozef than you will, staring at tapes."

"You're probably right," Bennett admitted. Rannveig's expression said she was sure she was right. She detached her seatbelt and bounded out of the studio. Faintly envious of her carefree attitude, Bennett made a copy of yesterday's events and fed it into a stereovision set.

In a way, watching death for the second, third, or twentieth time was harder than seeing it when it actually happened. There was always the dreadful, futile impulse to cry "Look out!"

Bennett sped through the murder of al-Kuwatly at fast forward; the athlete from the Arab World had never known he was in danger. Sheplov, though . . . Bennett got up, holding tight to the arm of his chair to keep from drifting to the ceiling. He studied the hologram from several angles, and became more convinced than ever that the Muscovite's arm motion was deliberate.

And if it was—Bennett interfaced the stereovision set with the big IBC computer. It took several false starts before he got the machine to do what he wanted: to give him a printout showing what section of Mimas' surface Sheplov had been trying to point at.

The circle that came out shaded in the printout was north of the jumpers' flight path, much closer to the landing area

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than to the runway. Depressingly, it was also about two kilometers across. But Bennett did not stay depressed for long. Major Katayama had been grousing about trying to cover 3,800 square kilometers; Bennett only planned to examine a bit more than three.

He checked his spacesuit's systems with the caution of a neophyte, then cycled through an airlock and bounded down onto the surface of the moon. Looking about, he could almost have thought himself on Luna. Dirty ice looked very much like rock, and one set of jumbled craters much like another.

Yet there were differences after all. Aside from the very low gravity, the sun, while still too bright to look at, was hardly more than an incandescent point in the sky. And one could never see several moons at once from Luna—not natural ones. Enceladus, Dione, Rhea, and orange Titan all showed visible discs, though none could compete with even the attenuated sun as a light source.

Remembering Angus Cavendish's comments on the jumpers' form on the funway, Bennett tried to stay as low to the ground as he could while he loped along. Even so, his motion was swift and almost dreamlike. He began to understand, however dimly, the feeling the athletes had as they soared into space.

The reporter steered by the inertial compass in his helmet. To his surprise, he saw people with lights moving about in the area he had decided to search. One of them saw him, too, and came bounding his way. A challenge rang in his earphones: "Who the devil are you, and what are you doing snooping around here?"

"Bill Bennett, IBC," he replied, and added pointedly, "I might ask you the same question." But the words were hardly spoken when he saw that all the people he was approaching wore the robin's-egg blue spacesuits of Security.

"Bennett, eh?" The guard was close enough to peer through his faceplate. "So you are," she admitted, lowering her sidewarm. "I think you'd better come talk to Major Katayama."

The Security chief greeted Bennett with a smile chilly as Mimas's ice. "How did you find out where we were searching?" he demanded. "If one of my people has been blabbing, I'll send him out here without a suit."

Bennett explained his method. He saw Katayama relax slightly. The broadcaster tried to retake the offensive: "Suppose you tell me why you decided to look here."

"I don't have to tell you a damn thing," Katayama said. Bennett was aware of how true that was; it had been a good many years since what was once called freedom of the press got more than lip service from officials. Public relations, though, still mattered. Katayama relented.

"Basically, we used a more sophisticated version of what you did," he said. "Once we had autopsy data, we could plot the trajectories of the beams that killed the three jumpers. This is where the lines came together. All the same, we still have a couple of square kilometers to go over."

Bennett hid his smile. The Security chief's technique hadn't narrowed the area down much better than his own. "Any luck so far?"

"We're still busy."

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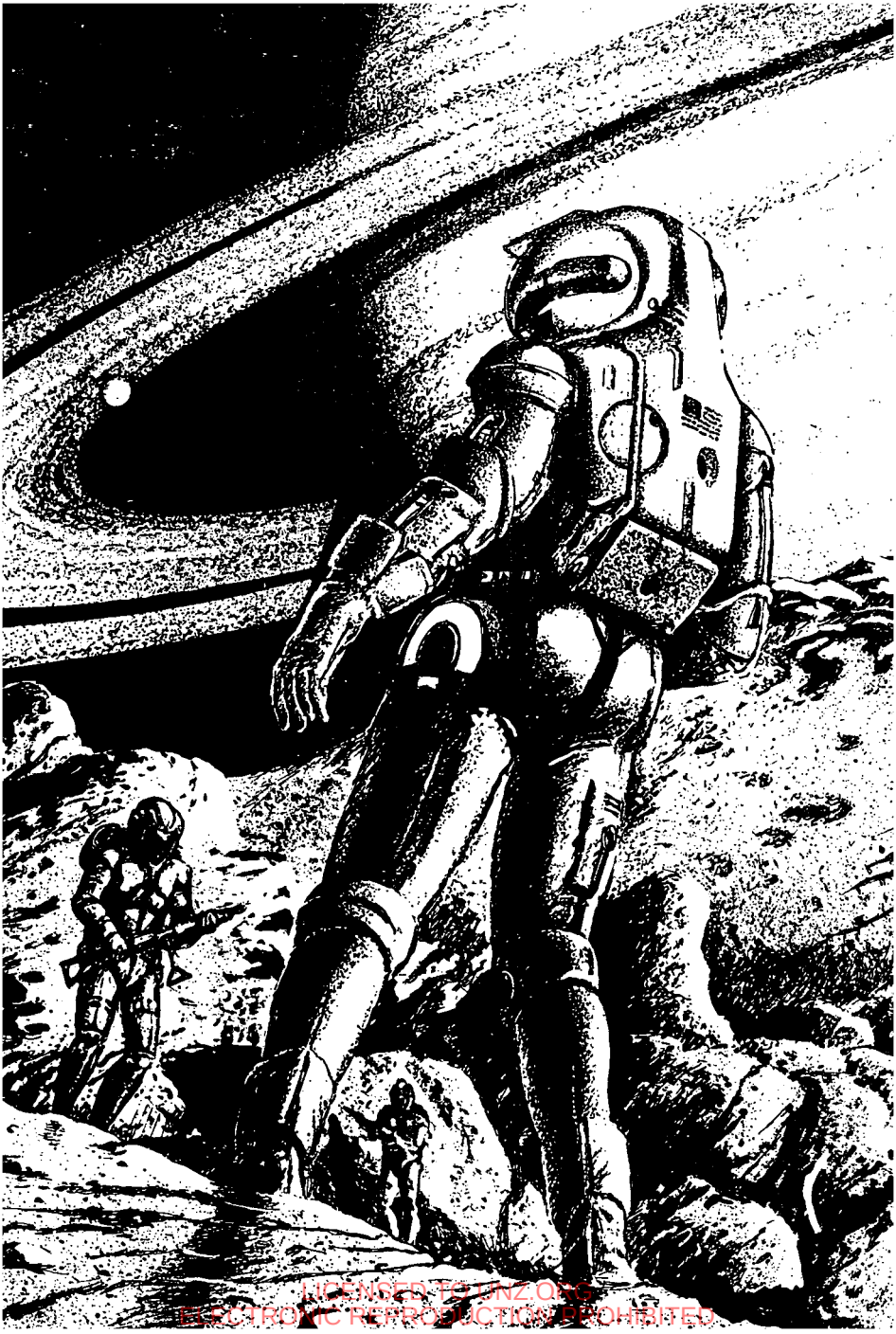

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No, Bennett translated. "Do you mind if I join you?" he asked.

After a brief hesitation, the Security chief shook his head. "Suit yourself. You might be lucky; who knows?"

Katayama's people were working in pairs. One would leap twenty or thirty meters off the surface, shining a spotlight down onto the ice to light a large area for the other team member to examine. The spots were brighter than the feeble sun, and illuminated inky shadows that might otherwise have made perfect hiding places. The Security personnel also carried metal detectors.

Without any such special gear, Bennett had to do the best he could using his helmet lamp and his eyes. He quickly learned not to look straight down; being mostly ice, Mimas reflected seventy percent of the light that struck it, more than enough to dazzle.

There were enough minerals in the ice to give the terrain some color beyond pure, cold blue-white. Some chunks —was that the word, Bennett wondered, or would "rocks" be better?—were grayish, others brown. The broadcaster nearly shouted for Katayama when he saw a rusty streak. But it had nothing to do with blood. It was only a tiny inclusion of iron ore, trapped for ages in the surrounding ice.

Bennett squatted to peer into a cave. He spied the edge of something green, away almost out of sight. He did not let excitement run away with him. Green beryllium compounds—emeralds, if you like—were a fairly common part of the stew of light elements from which Mimas had been made.

But if it was a crystal, it was very large and regular. Excitement shot through Bennett as he looked more closely—no crystal ever had writing on it!

He scrambled into the cave and reached down for it. The cold bit at his gauntlets, which were not as well insulated as his boots. He did not mind, though, not when he was holding an expended heavy-duty charge cube in his hands.

Then he keyed his suit radio, and Security personnel converged as if drawn by a magnet. They scoured the cave from one end to the other, and discovered two more of the plastic cubes, both better concealed than the one Bennett had found.

Katayama held out his hand for that one. Reluctantly, Bennett surrendered it. "It's one of the standard sizes," he said, "but not a type I know." He was looking at what were presumably instructions on the side of the cube. They were written in the Roman alphabet, but in no tongue he recognized. Whatever the language was, it went in for wild combinations of consonants.

"Made in Praha," the Security chief said. He seemed more willing to be informative now that Bennett had done something useful for him. Seeing the name meant nothing to the broadcaster, he actually unbent far enough to explain, "Prague, you would call it, I think."

"An Eastern European brand, then."

"Yes." Katayama fairly purred. "We have some interesting new questions to ask, wouldn't you say?"

"You certainly do. Sheplov must have seen the light leakage here when the killer fired at al-Kuwatly. Pity the cave roof kept the observation satellite from picking it up."

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"Yes. Still, we make progress." Katayama put his people back on the search to see if there was anything else to be found. Bennett helped for a while, but lightning did not strike twice. He headed back toward the Olympic complex.

One disadvantage of spacesuits is the difficulty of getting out of earshot. Katayama's voice rang in his helmet as if the Security chief were still standing beside him: "Don't use this until you get clearance from me. Do you understand?" When Bennett tried to ignore the order, Katayama snapped, "Acknowledge!"

"Acknowledged," the broadcaster said sulkily, but most of this pique evaporated by the time he returned to the Olympic village. Katayama had not said anything about poking around on his own.

When he had gotten back to the studio, he checked a list he already knew pretty well. It confirmed what his memory told him. Most of the Eastern European jumpers had had their turns toward the middle or end of the first day's run. They would not have had a lot of time to make any murderous preparations, and there would have been enough people about so that they could hardly have counted on not being noticed when they went to use an airlock.

He frowned. The conspicuous exception was Jozef Jablonski. Rannveig was not going to like hearing that. Unfortunately, she was probably going to, if not from Bennett then from Katayama. If the broadcaster could follow his nose this far, so could the Security chief.

As it happened, he got a chance to broach the subject when Rannveig came over to share a table with him at dinner. She bristled, just as he had known she would. He spread his hands placatingly. "I'm not telling you what I think, only what I found," he said, and wondered whether he was lying. "But we can both guess what Major Katayama will make of it. In his shoes, I'd do the same. Who else would use an obscure brand of charge cubes made in Prague but an Eastern European?"

"Someone trying to put the blame on one." Bennett made shushing motions; she had spoken so loudly heads turned.

He said, "Security men won't look at it like that; they shave with Occam's Razor. Do you know what your, ah, friend did after he jumped? Does it leave him in the clear?"

"No," she said, her voice low now, and troubled. "He told me he went back to his room and fell asleep. He was laughing at me; he said I'd kept him awake too long the night before."

"Not good."

"No," Rannveig said again. Bennett could see her wondering. She had, after all, only met Jablonski the other day. But then she shook her head, as if coming to a decision. "I can't believe it. He's just too—open—to kill from ambush. And what about the tape from the Second Irgun?"

"They denied it," he reminded her. "That's not like them; usually they're only too happy to take credit for their outrages."

"But why would Jozef want to kill any of the men who were shot?" she demanded. "What's the point? What would it gain him?"

"What would it gain anyone?" he

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asked. Neither of them could find an answer.

Bennett did not tell anyone but Rannveig of the find north of the jumpers' flight path, and he had no reason to think she noised it about. Nevertheless, rumors of all sorts raced through the Olympic village overnight. At breakfast Bennett heard claims that three different people had been arrested; one of them was drinking a bulb of coffee not three meters from him at the time.

He also heard that Jozef Jablonski was a secret Jew, which probably would have infuriated the skier from Gdynia; that the assassin was a renegade *ronin* from Japan (now there was a delightful prospect, he thought); that Moscow was about to declare war on Siberia or the Arab World or Eastern Europe or the Chinese Empire—which it did not border. But then, Moscow was always about to declare war on someone.

Brachiating back to the studio, Bennett almost ran into Itzhak Zalman. As they both slowed to avoid the collision, the jumper winked and said, "So tell me, have I been elected Pope in there yet?"

"Twice," Bennet said solemnly. As the athlete burst out laughing, he added, "Some of them also have you as a member of the Second Irgun, with 'Menachem's' threat part of your masquerade." He thought he saw Zalman's amusement slip for a moment, then told himself he was letting his suspicions run away with him. Pretty soon he wouldn't be able to look in a mirror and trust the face he saw.

How much the rumors about arrests were worth was proven when the second round of jumping was canceled again. The program that went back to Earth was correspondingly short. Because Bennett had been muzzled, there was next to nothing to say beyond repeating as many variants on "The investigation continues" as a skilled team of scriptwriters could concoct.

"Well, there's the easiest day of work I've had in a while," Angus Cavendish said when the shortened broadcast was over. "I think I'll check out a suit and do a bit of walking about. I haven't had the chance to play sleuth like you, Bill."

"Where did you hear about that?"

The Scotsman laid a finger by the side of his nose. "A wee birdie told me."

"A birdie in a Security suit?" That was Rannveig.

"However you please," Cavendish grinned. "Come with me, if you care to, and share the glory when we find the kern to blame for all this."

"Thank you, but no. Whatever Bill may fancy himself as, I'm no detective."

Cavendish turned to Bennett. "Are you game, Sherlock?"

"Why not? I'm at loose ends."

"Good. Nothing like a few brisk laps round the village to get the blood going."

Bennett tried to swallow a groan. That meant Angus was going to run the legs off him. The Scotsman was older, but he was also in better shape, more used to spacesuits, and had his bronze medal to prove himself a master at effective motion on Mimas. Rannveig, curse her, was giggling as she left the studio. The only exercise she was likely

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to get was more fun than anything you could do in a suit.

"Twenty-five laps suit ye?" Cavendish asked when they were outside. When they were by themselves they spoke English, but his burr was still strong.

"Whatever you say," Bennett answered.

"Shall we be off, then?" The Scotsman bounded away. Bennett followed. Cavendish held back to let him stay close. "Don't forget to kick up your oxygen flow," he warned. "Remember, you're working hard."

"I know," Bennett said. His breath was loud in his helmet; he would be panting soon. Cavendish's breathing sounded perfectly even in his earphones. He gritted his teeth and tried to keep up, but he kept bounding too high off Mimas and metaphorically spinning his wheels while he waited to descend.

The view on the far side of the Olympic village showed the moon as it had been for billions of years before men came to it: a giant lump of ice, much bombarded by cosmic debris in its early days. The far side of the village looked much like the near, although it had nothing to match the big view-window in the bar and although most of the airlocks led out toward the competition site. Bennett hardly glanced at the enormous, boxy structure as he puffed along behind Cavendish.

The Scotsman had gone round a good many times himself before he grunted, "What a queer thing that is," and did his best to come to a quick stop—not easy, with the velocity he had to shed. Still, he did better than his companion, who stumbled to a halt a quarter of a kilometer beyond him.

"What's the matter, pull a muscle?" Bennett asked. That would be funny, to have Cavendish's athletic body let him down.

But the Scotsman answered, "Nay, lad, nay," and pointed at the side of the building. Following his finger, Bennett saw a ring of frost high on the wall.

He wondered if it indicated a problem, but laughed at himself for the thought. "It's probably been there since the village was built," he said.

"No," Cavendish said at once, "because I didn't see it when I was here as a jumper. I made the laps then, same as we're doing now."

"That's crazy. Nothing ever changes in vacuum. Are you sure you haven't just forgotten?"

"I am." Cavendish sounded so positive Bennett had to believe him. "Bloody odd, I call it." With a shrug, he resumed his interrupted exercise. He shook his head the next several times the two of them bounded by the curious patch.

By the time they went back in to clean up, though, he seemed to have stopped worrying about it. Bennett, on the other hand, was still chewing on it as he stepped out of the shower cubicle in his quarters. That was a piece of plumbing that had required less adaptation to Mimas's conditions than he would have expected, though a stream of warm air, not gravity, kept the water moving.

Naturally, the phone chimed while he was drying himself. In his annoyance, he forgot to cancel the video feed. Rannveig nodded appreciatively. "As good as I remembered."

More pleased than embarrassed, he

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draped himself in his towel. "What's going on?" he asked, adding, "I thought you'd be with Jablonski."

"He's being questioned," she said bleakly.

"Oh. I'm sorry."

"So am I. I still think he's innocent, but there's evidence that points at him and none leading anywhere else, so what choice does Katayama have? I don't blame you for finding the charge cubes, or anything childish like that. And that reminds me—you really are turning into a first-class troublemaker, aren't you?"

"Am I? How?"

"Itzhak Zalman's asked for political asylum."

"He has? My God, with whom? Why?"

"With the Chinese, of all people; I think the Chinese coach must have been the first person he saw after he decided his cover was no good any more."

"His cover?" Bennett floundered.

Rannveig gave him an incredulous look. "You mean you don't even know? He panicked when you told him there was a rumor about his being a member of the Second Irgun—because it happens he *is* a member of the Second Irgun."

"I will be damned," Bennett said. That had never occurred to him. "I suppose Katayama's grilling him, too."

"He'd like to, but the Chinese coach hasn't let Zalman out of her suite; she's up on her hind legs over diplomatic immunity."

"That won't last, not in the face of murder," Bennett predicted. He could understand the Chinese coach's worry, though; no quarter was given on either side in the clandestine war between the Arab World and the exiled Israeli nationalists.

Bennett dressed, then called Katayama. The Security chief came on the line after a delay of a few minutes. His face was impassive, but there was something like warmth in his voice, and the fact that he was talking to Bennett in person showed how the broadcaster's stock had risen. "Well, Mr. Bennett, you've helped me twice now. What can I do for you?"

"What's the story with Itzhak Zalman?"

Katayama's smile touched only his lips. "News travels quickly, I see. We have a recording in which he states he planned no violence, only a loss of face for the Arab World upon the disclosure of its slipshod security procedures. The value of this statement, of course, remains problematical. We would like to interrogate him in greater detail, but, ah—"

"I've heard," Bennett nodded. "What about Jablonski?"

"About what you would expect. He denies any knowledge of the killings, says he was alone, asleep, and that if he were guilty he would have a better alibi." A slight lift of one eyebrow showed how often Katayama had run into that sort of infinitely regressing logic.

Bennett thanked him and let him go; no point in using up his store of goodwill by keeping the Security chief away from his job for a half-hour. There had been something else the broadcaster had been thinking of doing when Rannveig's call drove it out of his head. He snapped his

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fingers in annoyance, trying to remember.

He was on the point of giving up when it came back to him. He punched the chief maintenance engineer's number.

He did not get the head of the engineering department; that worthy had no reason to drop what she was doing on account of his call. The assistant he talked to was a blond young man whose Anzac-flavored English was amusingly different from Cavendish's. He described the frost he and the Scotsman had seen.

"We'll check it out, mate, never fear. Don't get browned off," the engineer said cheerily.

"What was that?" Bennett snapped, sensitive to anything that sounded like a racial slur. Then he recognized the idiom. "Never mind," he said lamely. "Would you call me back when you find out what it was?"

"Will do, mate. G'day to you." The screen went dead.

Having done everything he could think of, Bennett settled down to wait for the return call. He checked the computer for a listing of entertainment programs, and found on one of the stereovision channels a docudrama he hadn't seen.

The show was based on the works of a great twentieth-century author, and harrowingly realistic. Characters got killed off one after another; even the hero ended up in a cancer ward. The blizzards made Bennett feel colder than anything on Mimas had.

He jumped at the chime of the phone. Switching off the stereovision was something of a relief. The Anzac engineer looked out of the screen at him. "Thanks for the call, mate. Bloody funny thing, that," he said, unconsciously echoing Cavendish.

"Is it dangerous?" Bennett asked. "That's what I was worried about."

"Shouldn't be. Can't cypher out how the hell it got there, though—it would've taken enough outgassing to suck all the air from a set of rooms, but we've had no exploding guests, for which I'm bloody grateful, I can tell you."

"Whose rooms would it have been?"

"I'll have to check, mate. Let me feed the outside wall coordinates into the computer. . . ." He turned away, fiddled with a keyboard for a minute or two. "Here we go," he said, and gave Bennett the name.

"Thanks," said the broadcaster, he had to stop himself from adding the Anzac's infectious "mate." He broke the connection and went back to the stereovision docudrama with the nagging feeling he was missing something, maybe something important.

"There!" He could have kissed the ugly, unshaven *zek* on the stereovision screen. He broke a fingernail punching Katayama's phone code. The woman he talked to had been one of the Security people closest to him when he found the expended charge cube; she smiled and went to fetch her chief without any argument.

This time Katayama took longer to come to the phone. When he finally did, he growled, "No matter what you may think, Mr. Bennett, I am not at your beck and call. I am trying to do an important job, and your interference does not help. Now, and quickly, what is it?"

"I beg your pardon," Bennett said

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sincerely, "but I wonder if you might answer me one question?"

The Security chief heard him out. "Yes, of course that's still true," he said, as if surprised anyone needed to ask. "I suspect it will be true two hundred fifty years from now, too; some things don't change. Now I wonder if you'd tell me what possible importance there is to that?" He framed the last sentence as a request, but it came out a command.

Bennett explained. As he did, he half expected his jerrybuilt structure of logic and wild guesses to come crashing down on his head and leave him looking like an idiot. Katayama listened in silence, not showing what he was thinking.

When Bennett had finished, the Security chief ran a hand through his hair. "I take it you write thriller plots?" he said at last.

"No." Below the camera's angle of vision, Bennett clenched his fists. This was what he had set himself up for, trying to help . . .

But Katayama was saying, "I can find out quickly whether or not you are right—no small virtue, in my line of work."

"Will you call me back?" the broadcaster asked tensely. He knew he had had to do as he did, but he hated the idea of being excluded as soon as things came to a head. He still had too much of the old American reporter's itch to be in on the action instead of just talking about it.

Katayama, on the other hand, had no use for reporters unless they served his own purposes. "I make no promises, Monsieur Bennett," he said, and hung up.

In .008-g it was impossible to pace, but bouncing off the walls, floor, and ceiling, as Rannveig had in the studio, was not the worst way to get rid of tension. Bennett had worked up a good sweat by the time the phone chimed again. "Hello?" he panted.

His disheveled appearance managed to wring a blink out of Katayama. "What have you been doing?" the Security chief asked, then said at once, "Never mind; I am not interest in knowing. I have called to tell you what you are going to do. Listen carefully—"

Bennett and Rannveig took their places in the IBC studio. When the red light on the camera flashed on, Bennett began, "A very pleasant good day to you out there, wherever you may be. There have been a number of important developments since we spoke with you last."

"That's right, Bill," Rannveig said. "We expect this to be the last day of shortened coverage of the Games. The jumping should resume tomorrow."

"The arrest of Jozef Jablonski has lifted a great burden of fear from everyone's shoulders," Bennett agreed. Rannveig nodded, a little glumly; Bennett went on, "The evidence against Jablonski is overwhelming. The site from which the killer fired from ambush has been discovered, and the discarded charge cubes found there were manufactured in Eastern Europe. It is most unlikely that anyone from another country would have had such an obscure brand in his or her possession."

"Moreover, Jablonski cannot account for his whereabouts at the time of the murders," Rannveig said. "He

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is currently being subjected to intensive interrogation, and his confession is expected shortly by Major Katayama."

Bennett said, "As you can imagine, ladies and gentlemen, the people most relieved are the athletes themselves. For some of their reaction, let's go to Angus Cavendish."

"Thank you, Bill," the Scotsman said. As before, he was sitting at the bar—getting to be quite a fixture there, Bennett thought. Almost everybody there was watching the stereovision set in a corner of the room, and thus at the moment watching themselves watching themselves. For any news more reliable than rumor, they depended on the IBC broadcasts as much as Earth did.

Cavendish alluded to that point: "I'd think almost all the athletes on Mimas are tuned to us now. Along with the set here, there's another in the weight room, and of course in all the suites."

"Who's that with you, Angus?" Rannveig said.

"Marge Olbert, the first-round women's leader. Tell me, Mademoiselle Olbert, what are your feelings now that an arrest has been made?"

"I am, how does one say it, full of relief," she replied in halting French.

"Eager to jump again, are you?"

"But yes, naturally, and I hope to do well, it could be to win a medal." Her sudden and unexpected smile transformed a rather plain face into a pretty one. "And if I do, at the least they will know what flag to fly for me when I am on the platform of the winners. For Monsieur Zalman this is not true, is it not so?"

"An interesting point you bring up, lass." Cavendish had the minutiae at his fingertips. "As a matter of fact, there is a precedent. In the Summer Games of 2104, a woman from the United States defected to Indonesia after the first two events of the modern pentathlon. She won a silver, and took it under Indonesian colors."

"Ah." Marge Olbert hesitated, then went on, "I only hope they have arrested the right man. This Second Irgun, it is supposed to be very bad, no? If somehow there is a mistake, that would not be good."

"There's confidence Itzhak Zalman had naught to do with the killings," Cavendish said. "Even if there weren't, he's been too closely guarded for his own protection to let him go off doing mischief."

"I hope you are right," the Anzac jumper replied. She left, and Cavendish interviewed several other athletes. They were all of them polite, but none said a great deal.

"That's one of the abiding problems of sports journalism," Rannveig said when the show came back to the IBC studio. "The cliches were invented in the twentieth century, and they've been repeated ever since."

"Perhaps we can get a fresher perspective from a competitor with a different background," Bennett said. He made the call he had set up the night before. "Thank you for joining us again, Monsieur Yezhov."

The Siberian dipped his head in a courtly gesture of acknowledgment. "Not at all," he said, his French excellent as usual.

"Would you care to give us your reaction to the arrest of Jozef Jablonski?"

"I was, to be frank, surprised; he

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seemed a very decent fellow, though I did not know him well." Yezhov paused, considering his next words. "But if he is truly the one who perpetuated these abominable deeds, then I am glad to see him in custody. I look forward to the recommencement of the Games."

Bennett's heart was pounding in the effort to stay natural. "Are you—" he began, then broke off at the sound of a knock on the outer door of Yezhov's suite.

"I shall ignore that," the Siberian said politely.

"No need," Bennett assured him. "We don't want to inconvenience you when you are kind enough to talk with us; we'll cut away and then come back to you when you've finished. If your visitor's business isn't too personal, though, perhaps you might leave the vision link open with us while you turn down the sound, so we can tell when you're coming back."

"A capital idea. I shall do as you suggest."

Yezhov reached out for the volume toggle, then turned his back on the phone camera and glided toward the door. Instead of going to a commercial or a taped segment, though, the director kept the Siberian's image in the big screen behind Bennett and Rannveig.

"Welcome to those watching all over Earth," Rannveig said quickly. "We apologize for starting our coverage late, but—"

At that moment, the Siberian touched the door control switch. The door slid open. A Security guard thrust a pistol in Yezhov's face. Half a dozen more, including Major Katayama, rocketed past him into his suite. One doubled back to wrench the Siberian's hands behind him and clap manacles on him; the rest began tearing the place apart. Somehow the impact of everything was greater because on the screen it all took place in silence.

"—at this moment you are watching the capture of Nikolai Semyonovich Yezhov, the assassin whose crime has marred these Winter Games." Rannveig went on, "I'm proud to say that my colleague here at the IBC sports desk, Bill Bennett, played a key role in Yezhov's arrest. How did that happen, Bill?"

"Let's wait a moment before going on with the details, Rannveig," he said. Modesty was not what held him back; far from it. He felt full to bursting with triumph, and with relief—if anything had gone wrong, a technician would have made sure Earth never saw it. But now the unfolding story came first. "Here's our camera crew arriving at Yezhov's door. Let's watch as the Security patrol searches the suite. They know what they're looking for."

The picture on the screen behind the broadcaster shifted from the view out of Yezhov's phone to one from the IBC crew. One of the Security women tore down a rug on the far wall of the suite, to reveal a circular scar, two meters wide, cut in the metal and ceramic and inelegantly patched.

"There you see how the killer avoided being spotted or perhaps even being captured at an airlock when he returned to the Olympic village after he had committed his three murders. He did not use the locks either to leave or enter the village complex. Instead, he cut his way out of the building with a laser torch,

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undoubtedly the same one he used to kill Shukri al-Kuwatly, Dmitri Sheplov, and Louis-Philippe Guizot. Once he had the opening cut out, he simply jumped to the ice below and went to his ambush point."

"Of course," Rannveig nodded. "A fall of forty meters here is nothing, the same as less than half a meter on Earth."

"That's right, and the return jump is the same—easy for anyone in Yezhov's excellent condition. To go out without being noticed, all he had to do was close the door to his suite; like all doors here, it's gastight so there would have been no pressure drop outside his rooms to give him away. Afterward, sealing compound let him repair the damage he'd done, as we can see now."

"Where did he go wrong, then?"

"Over something he had no way to hide. Some of the water vapor and CO_2 that escaped from his suite condensed against the side of the building. The slab he'd cut out was free of the crystals —once replaced, it looked like a bullseye. But it was on the side of the village away from the jumping, where hardly anyone ever goes. And even if they did, they'd think the deposit of ice had been there forever. Angus Cavendish knew better, though."

"I suppose he was also aided by Siberia's national colors," Rannveig said, thinking fast on her feet. "His white spacesuit would have made him hard to spot, both on the ground and from the observation satellite."

"Yes."

While they talked in the studio, the Security team was examining the case of the stereovision set in Yezhov's rooms. The IBC camera crew caught a technician's exclamation: "There's tampering here, no doubt about it."

"Take it to the lab," someone else said. "If there's more inside, we'll have nailed down where he got his laser tube."

"Yezhov said he installed stereovisions in, where was it, Kolyma," Rannveig remembered.

"Unh-hunh," Bennett said. "That was something else that should have made us take a hard look at him, but didn't."

"Why should it have?" Rannveig asked. The question was not just for the audience, but for herself. Bennett simply had not had time to explain everything to her, although she was coming through like a trooper.

He said, "Kolyma was one of the biggest slave-labor camps in the days of the old Soviet Union. From what I've been able to learn, that's still true in Czarist Siberia—and slaves need guards." Both Siberia and Moscow, he felt sure, would censor this part of the broadcast, but the rest of the world needed to know. He would never have found out himself if he had not seen the show about Aleksandr Solzhenitsyn the day before.

In the screen behind the broadcasters, Nikolai Yezhov directed an ironic bow toward Major Katayama, his head being the only part of him still free to move. "My compliments," he said with as much aplomb as if they had met at a banquet rather than as killer and captor. "I take it the announcement of Jablonski's arrest was for my benefit, and not sent on to Earth?"

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Katayama nodded brusquely. "You admit this, then?"

"My dear sir, at this stage of affairs, what good would it do me to deny it?"

The Security chief grunted. "Not much. Do you have anything to say before we deal with you?"

"May I request a lawyer?" Both Yezhov and Katayama smiled at that; the world was a harder place than it had been a couple of hundred years before. Having been caught, the Siberian could not expect to live long.

"Get on with it," Katayama told him.

"Yes. How should I put it? Perhaps that I chose to strike a blow for Holy Mother Russia against the godless Marxists who still disgrace us all by holding Moscow. We in Siberia have cast them down; even China and Eastern Europe overthrew their ilk years ago. Only Moscow still clings to the outworn creed. We fought them a few years past. I do not care if peace was sworn; between us and them can be no peace."

That led inevitably to Katayama's next question: "If your fight was with Moscow, why did you also kill the other two, and why cover your tracks?"

Now Yezhov looked at the Security chief as at any fool. "To avoid embarrassing my country, of course. Too many people in the world would not understand how honor compelled me to act as I did."

At last something angered Katayama. When he answered, Bennett could hear in his words the revived tradition of *bushido* that had gone with Japan's emergence as a military as well as an economic power in the later twenty-first century. "There is no honor in shooting men from ambush," he said implacably.

He turned to the Security people who held the Siberian, snapping, "Get him out of here."

The camera crew followed them down the corridor, and almost ran into the coach of the Siberian team, who came swinging from one ceiling handhold to the next like a desperate ape. When he spotted the camera, he almost threw himself in front of it. He started speaking in Russian, a true measure of how upset he was.

He checked himself after half a sentence, began again in French: "I must say, on behalf of Siberia and the Czar, that what Nikolai Yezhov has done is the act of a solitary madman. I condemn him as strongly as any man alive; my heart goes out to the dear ones of the men—*all* the men—whose deaths he caused. Our Russian brothers of the People's Republic of Moscow must know the firmness of the treaty of Sverdlovsk—"

He went on for some time. After a while he began repeating himself, but the director did not cut him off. The chance that his apology might be heading off a war was too real to disregard—and the urgency behind that apology made for incomparably dramatic stereovision.

The Siberian coach finally finished and departed to give his condolences to his Muscovite opposite number, his head still hanging in shame. The director's finger stabbed toward Rannveig; the camera in the studio swung her way.

She said, "Once again the specter of nationalism has wounded the Olympic Games, the games that should be the

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chief symbol of cooperation between nations. Nationstates have existed for more than six hundred years now. If they haven't yet learned to live together in that time, will they ever?"

"I think that may be too dim a view, Rannveig," Bennett said. "Your own United Europe is a case in point, and Eastern Europe, and the Arab World. Step by step, we make progress."

"But will it be enough?"

He shrugged. "The only answer is that we're here. We haven't managed to blow ourselves up, quite. And tomorrow, in spite of everything, the Games begin again. That's worth remembering, you know."

"Cut," the director said. ■

ON GAMING

(continued from page 141)

mad computer that thinks everyone in a future underground community is out to "get" it. Difficult to play solitaire.

Sanctuary (Mayfair Games Inc.)

You play a thief and try to become the richest player in this board game based on Robert Asprin's anthologies about a city of thieves. Solitaire potential is good.

Star Commander (Historical Concepts)

You "build" your space vessels (and try to sabotage your opponent's fleet), then attack with your starships in this unique card game. It's possible to play this game solitaire, but it's more fun with two or more players.

Star Fire (Task Force Games)

This is a simpler version of Task Force's popular *Star Fleet Battles* game about tactical starship combat. It's not easy to play solitaire, but it can be done.

Star Trek: The Role-Playing Game (FASA Corp.)

You participate in the famous television and movie series as a member of Star Fleet Command. Not designed for solitaire play.

*Star Trek III: Starship Duel** (FASA Corp.)

A combat "wheel" is used instead of a board or a book to show each starship and its enemy's location. Difficult to play solitaire.

Talisman (Games Workshop U.S.)

A board game that incorporates many elements of fantasy role-playing. Your character must travel to the center of the board and seize the "crown of power." Can be played solitaire.

Traveller®** (Game Designers' Workshop)

A role-playing game about pirates, bootleggers, and mercenaries in space. As *D&D*® is to fantasy role-playing, *Traveller*® is to SF role-playing. Difficult to play solitaire.

If you'd like to look at or buy any of these games, visit your local game or hobby store. Good gaming! ■

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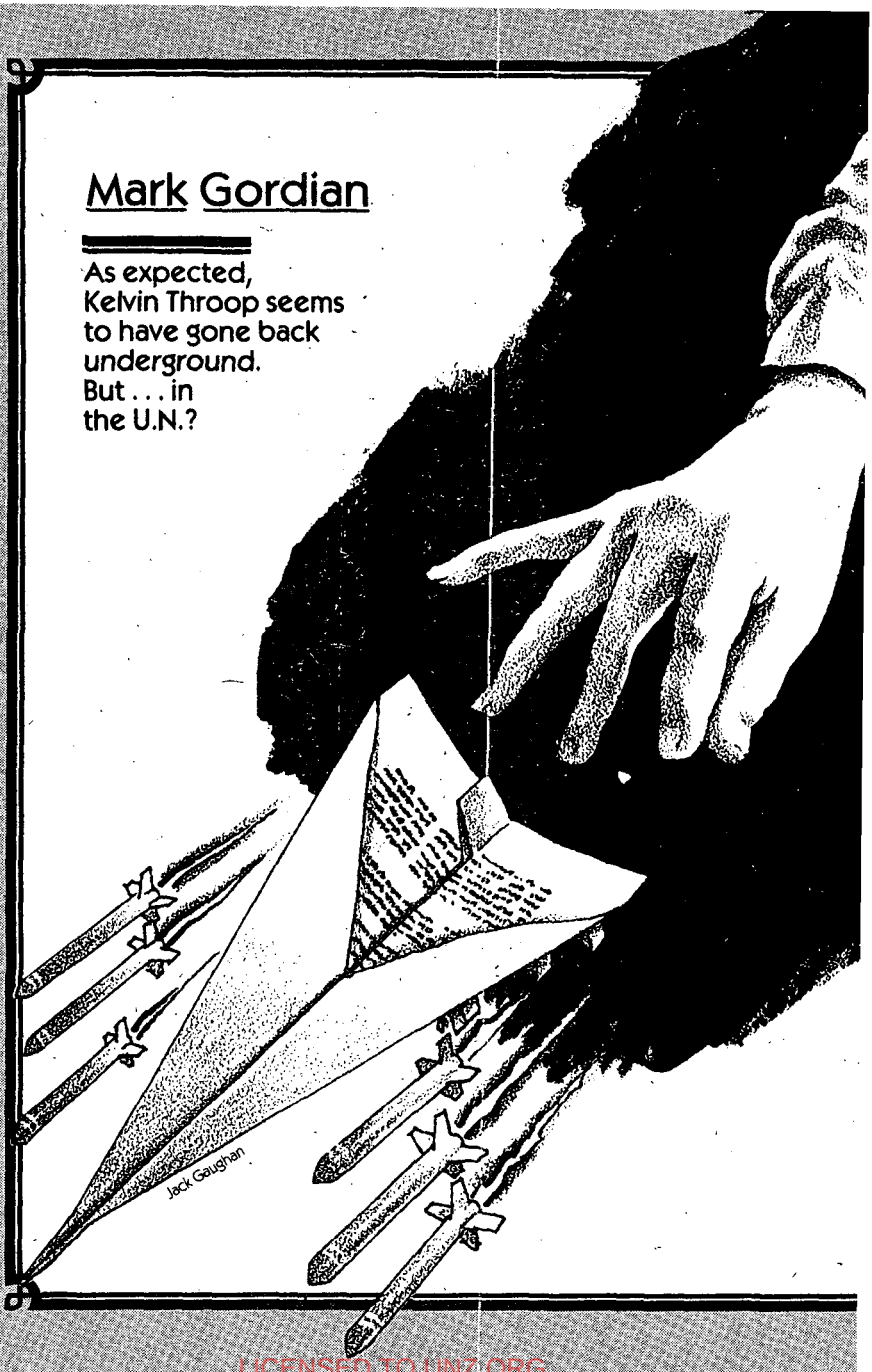
Mark Gordian

As expected,
Kelvin Throop seems
to have gone back
underground.
But . . . in
the U.N.?



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NOTES FROM THE GENERAL SECRETARIAT

Dear 100% American,

Of course the United States should pull out of the United Nations. After all, what has the other 94% of the human race ever done for the U.S.A.? I plan on quitting here myself, as soon as I get my Toyota paid off.

Patriotically,
Beals Becker

Dear Señor,

Your contention that the United States is and always has been "at the forefront of imperialism and aggression" is borne out by the fact, known to the entire world, that Cuba has been an American state since the U.S. annexed it after the Spanish-American War.

Should you heed the lessons of history that Marxism claims to revere, you would discover that when the United States went to war with Spain, it specifically rejected taking over Cuba. Moreover, when the war was over, the U.S. helped set up a Cuban administration, standardized schools, arranged elections for a constitutional assembly, and wiped out yellow fever.

May your nation escape another such ruthless takeover.

Dialectically,
Beals Becker

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Dear Dr. Heppelwhite,

After sitting down with a dictionary and a *very* thick grammar, I've concluded that you want to help people in developing nations learn to read and write. Well, good for you. A lot of other folks are already working on that, but it is important and every warm body helps.

Or so I would have said, until your letter. Since what you actually proposed, however, was "the implementation of systems and/or modalities to impact literacy-impaired populations and the development of programmed activities to facilitate the enhancement of linguistic/literary skills," I'm afraid you're part of the problem, not part of the solution.

If you can't get across what you mean, how do you expect people to pay any attention to you? And why should they?

Clearly,
Beals Becker

Dear Minister Karamat,

Yes, the Secretary-General has received your latest letter requesting food and other relief. He has also received both letters from last week, the one the week before that, and the three the week before *that*.

As he has delegated replying to me, I would point out that, while your country is slightly smaller than Wisconsin, it has just under a hundred million people and is adding a couple of million every year. That's your real problem.

Perhaps you should think about importing parcheesi sets, backgammon gear, or Doris Day movies to take your people's minds off what is obviously their main current source of amusement. Oh, yes, and using the money you spent on your last order of MiG's for something else might have been a good idea, too.

Hungrily,
Beals Becker

Dear Professor Kroonstad,

The mere fact that humanity may first have developed in what is now South Africa does not entitle the present occupants to any special status in the U.N. For one thing, the present policy of the government convinces me that very little evolution has gone on in those parts for a long, long time. For another, don't you think it's likely those first men were *black?*

Primevally,
Beals Becker

To the members of FLATUS:

Have mercy, I beg you! The U.N. normally has no truck with terrorists, but plainly we have met our match in the Ferocious League Against Those Using Sarsaparilla. Your threat to destroy the world's entire sarsaparilla crop has thrown governments and commodities markets around the world into chaos.

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Under the circumstances, your demand for a ransom of only $800,000,000 is astonishingly reasonable. As you specify, we will airdrop the money into the jungle of Belize. You requested small, unmarked bills to ensure you could use the ransom without fear of retribution. I've taken the liberty of going one step further: you will be paid in nickels. Now, if you will be so good as to inform us *exactly* where you'll be and when you'll be there, we'll drop 'em on you for you.

Yours from above,
Beals Becker

Dear Ayatollah,

If God has already told you what's going to happen, why are you bothering *me?*

Merely mortally,
Beals Becker

Dear Commissar,

The U.N. always welcomes disarmament proposals, wherever they come from. Nobody here much likes the idea of being blown away. Seeing your government espouse that cause is a pleasant novelty, the more so as we'd all be a lot better off if you'd done it right after World War II, when it really would have counted.

The Baruch Commission would have put all atomic materials under the control of an international commission, which might have made the organization I serve something more than a glorified debating society. And wouldn't that have been better than worrying about American and Chinese missiles aimed at your cities, and wondering what you're going to do when fanatics get the bomb, say next Tuesday?

Pacifically,
Beals Becker

Dear Representative of the Republic of Vanuatu:

You mean there really *is* a Republic of Vanuatu? Damn! Now I'm going to have to pay Serge the twenty bucks I bet him. Looks like peanut butter till payday.

Disappointedly,
Beals Becker

Dear Ambassador,

Congratulations! The Israeli government's basing its claim to the lands your country has occupied in various wars since 1967 on Biblical precedent wins this year's United Nations award for most splendidly antique irrelevance.

No other government or organization came close. The Arab claim to Palestine dates back only to the seventh century A.D., the Greeks and Turks have been fighting over Cyprus for just the past four hundred years, and the Ulstermen have been in northern Ireland for a mere three centuries or so. Pikers, the lot of them!

Aren't you glad no Canaanites are left to complain about the way the Hebrews dispossessed them? They could have given you a run for your money.

Awedly,
Beals Becker

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Your Excellency:

In light of the recent tragedy, your call to ban pesticide plants from being placed in underdeveloped nations is perhaps understandable. It's also damned shortsighted. More people will starve because of the pesticide that doesn't get made, than were killed or hurt in the disaster.

But they'll do it quietly, over years, and that won't let you show up on television or sue a foreign company for billions of dollars. By the way, from everything I've read the safety precautions were adequate, or would have been with properly trained people on duty. The foreign company didn't have anything to do with that; the locally owned subsidiary did. Think about it.

Seriously,
Beals Becker

Dear Professor Nagas,

I wish the U.N. could support your search for extraterrestrial intelligence, but we don't have the money. Also, unfortunately, we've found *terrestrial* intelligence to be in such short supply that we have to do our looking closer to home.

Sympathetically,
Beals Becker

Dear Mme. Ambassador,

Blaming the structure of the General Assembly for the fact that a lot of votes go against the United States these days strikes me as counterproductive. This is especially true since the U.S. set up the General Assembly so a lot of votes would go against the Russians. The shoe's not so comfortable on the other foot, is it?

Instead of carping, you might want to think about *why* so many countries vote against you. Doesn't it strike you as ironic that a nation that had a revolution in the cause of freedom now blindly seems to oppose change wherever it threatens to appear? If your friends include Chile, the Philippines, South Africa, and the deposed colonels in Greece, being an opponent can start looking awfully good.

Being rich will get you envied, too, even if you try to be an angel—sometimes more if you try to be an angel. Get used to it.

Impatiently,
Beals Becker

Dear Ms. Lefebyre,

I have referred to my superior your excellent plan for making the U.N. into a world governing body with real power to prevent war. I'm afraid she laughed too. Try us again in a couple of hundred years.

Wistfully,
Beals Becker

Dear Pragmatist,

In regard to your proposal for using compulsory euthanasia to control population,

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may I assume you are volunteering?

Hopefully,
Beals Becker

Dear Herr Jäger,

Of course the U.N. is aware that the present German frontiers are not the result of any formal treaty. Nevertheless, I don't expect the representatives of either the *Bundesrepublik* or the DDR to complain any time soon. They remember, as you fail to, against whom the United Nations united in the first place.

Nie wieder!
Beals Becker

Dear Physiqueworks Gym Chain,

Yes, I am interested in "building the body I've always wanted," to quote your recent ad. Please immediately send me the kit for this past year's Miss November.

I shall be awaiting its arrival,

Eagerly,
Beals Becker ■

● As we have seen in our discussion . . . of the fertility of freedom, the restriction of economic freedom may inhibit individuals from discovering opportunities they might have noticed had they been free to exploit them. Loss of freedom may thus lower individual and social achievement without anyone's realizing what has been lost or not achieved. A free society is fertile and creative in the sense that its freedom generates alertness to possibilities that may be of use to society; a restriction on the freedom of a society numbs such alertness and blinds society to possibilities of social improvement.

Israel M. Kirzner

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the reference library

By Tom Easton

Jitterbug Perfume, Tom Robbins, Bantam, $15.95, 342 pp.
Dreamwatcher, Theodore Roszak, Doubleday, $15.95, 287 pp.
Ariel, Jack M. Bickham, St. Martin's, $15.95, 316 pp.
Artificial Intelligence: How Machines Think, F. David Peat, Baen Books, $8.95, 370 pp.
Armor, John Steakley, DAW, $3.95, 426 pp.
Chapterhouse Dune, Frank Herbert, Putnam's, $17.95, 464 pp.
Star Healer, James White, Ballantine/Del Rey, $2.75, 224 pp.
Alien Stars, Elizabeth Mitchell, ed., Baen Books, $2.95, 254 pp.
The Inventions of Daedalus: A Compendium of Plausible Schemes, David E. H. Jones, W. H. Freeman & Co., $11.95, 204 pp.
A History of the Hugo, Nebula, and International Fantasy Awards, Donald Franson and Howard DeVore, Misfit Press, $6.00, 185 pp.
Age of Wonders: Exploring the World of Science Fiction, David Hartwell, Walker, $15.95, 205 pp.

Some time ago, I heaped praise on *The Silent Gondoliers*. To tell you who the author, S. Morgenstern, was, I quoted the jacket copy. And that's a common practice of reviewers, who are always in a hurry and who do *not* always recognize the name on a book's cover. I was thus a mite embarrassed to learn later on that Morgenstern was a pseudonym for some unidentified but well-known writer. I had fallen for it, and now there was only one way to retrieve my fallen ego. Somehow, I would have to figure out who Morgenstern really was.

Fortunately, I have here a book that may help. The author is recognizable; outside SF, he is known for *Even Cowgirls Get the Blues*, *Another Roadside Attraction*, and *Still Life with Woodpecker*. The style and tone have

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distinct resemblances to those of *Gondoliers*. And there is a character named Morgenstern: He lacks the initial S., for his name is Wolfgang, but he did study at the Sorbonne. And he spends a lot of time jumping up and down, striving to dance his way to immortality.

So tell me, Tom Robbins. Did you write *The Silent Gondoliers* as well as **Jitterbug Perfume**? (Or does everybody already know what I have just guessed, rightly or wrongly?

Perfume is an insistently, persistently clever book, full of dreadful puns (Chinese immortals live for "a won won ton") and obsessively cute descriptions ("Every toilet bowl gurgled like an Italian tenor with a mouthful of Lavoris, and the refrigerator made noises at night like buffalo grazing."). The book is thus at times a wearing thing to read, but its language alone offers the occasional belly-laugh and chuckle. The story is less funny, but still it entertains nicely.

We begin with Alobar, king of a small Bohemian valley a thousand years ago. His people believe that they must kill their kings as soon as they show signs of age, so Alobar is perturbed when he discovers his first gray hair. He decides that he would rather not die, thank you, and escapes with the aid of his most intelligent wife, Wren. He becomes one of history's first true individualists, taking the quest for an answer to death as his mission. He wanders eastward. He meets and sports with a weakening Pan. In India, he meets the eight-year-old Kudra, an incense-maker's daughter who reminds him of Wren, and binds her never to commit suttee. In the Himalayas, he flees the apparently immortal Bandaloop doctors and settles with lamas. For twenty years he learns peace, and when Kudra turns up again, he is delighted. Together, they dwell in the vacated caves of the Bandaloops, soaking up techniques of immortality from the sanctified stone of the walls around them. Eventually, they wander off to explore Europe for seven centuries. In the 1600s, they open a perfume shop in Paris. There, in time, they experiment with dematerialization, Kudra vanishes, and Alobar devises the ultimate perfume, K23, to hide the stink of Pan.

And all this is merely background. Much of the story occurs in our present, when various parfumiers are seeking jasmine-based wonders, the drug-crazed immortalist Wiggs Dannyboy is leaving beets on their doorsteps as clues to K23, and Alobar is praying for release from jail. There is zaniness and marvel and wonder. There is delight in people and language. There is even a recipe for immortality—circular breathing, good diet, hot baths, and sex.

Perhaps more to Robbins's point is his stress on the paramount sanctity of individualism. Immortality is possible, says he, only to true individuals: "Our individuality is all, *all*, that we have. There are those who barter it for security, those who repress it for what they believe is the betterment of the whole society, but blessed in the twinkle of the morning star is the one who nurtures it and rides it, in grace and love and wit, from peculiar station to peculiar station along life's bittersweet route."

Gondoliers said much the same thing, didn't it?

Robbins is, of course, one more deserving recipient of the "Mainstream Invades SF!" headline. They crop up regularly, more now than ever before, for—if you hadn't heard—SF is respectable at last. Writers who served their apprenticeships elsewhere are learning that the only way to write about the fu-

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ture, science, or technology is to use the SF idiom. Often enough, these writers are so unfamiliar with that idiom and its demands that they publish worn-out plots and display a spottier awareness of technical truth than we are used to.

The mainstreamers usually come one at a time. This month, I have three at once. And all are much better than I would have expected. They are even much better than most of the "native" SF that comes my way. We're being invaded, folks, and we may actually wind up better off for it.

My second is Theodore Roszak's *(The Making of a Counter Culture; Where the Wasteland Ends)* **Dreamwatcher**. Roszak's premise is that there exist people, often autistic as children, who can invade other people's dreams in their sleep. Deirdre Vale is one such person, and she finds in her husband's dreams a malign presence that is destroying him. She steps in as a defender, and the presence drives Peter to kill two of his three kids, attack Deirdre, and then kill himself.

Deirdre is drawn back from madness by that kindly shrink, Dr. Devane, head of the famous Devane Clinic, who enlists her talent to help him in his study of autistic children and other patients. He does not tell her that he was responsible for Peter's death: He had discovered dreamwatching years before and let himself be co-opted by a secret national agency; he has trained watchers to invade and twist dreams, to bend people to this agency's desires, or to break them.

Lovely stuff, that. Roszak establishes a situation that seizes the mind, and he does it in a fairly low-key way, never geeking just to get our attention. And then he brings in the new mission: a saintly Guatemalan nun, a resister of terrorists and tyrants, who is in embarrassing exile in the U.S. and who seems likely to cop the Nobel Peace Prize. The powers that be want her discredited, and they come to Devane. He is to get a handle on her psyche, and then they will use the best watcher he ever trained to destroy her.

More lovely stuff, especially when Devane uses Deirdre to study Sister Constancia's dreams and she meets there the same malign watcher she last sensed within her husband. There is psychic battle, physical murder, death of villains and coma of heroine, and a final war against a revenant. There is unremitting focus on the cynicism and condescension of the manipulators of this world and on the potency of imagery, both Christian and pagan, psychological and philosophical. There is . . . there is a book you should not miss.

There have always been tales of intelligent machines, but there seem to have been more such tales since the microcomputer revolution. Integrated circuit chips have made powerful computers small and cheap, and many people—writers and scientists alike—expect this revolution to culminate in true artificial intelligence. Thus, the tales, and Jack M. Bickham's **Ariel** is a distinguished addition to the roster.

Bickham is our third mainstreamer, even if his name is not familiar to SF readers, and he may be one to watch in the future. A teacher of writing at the University of Oklahoma, he has produced several other books. His latest, says the dust jacket, was something called *I Still Dream About Columbus*.

The hero of his present tale is genius entrepreneur John Harrington, founder and president of troubled Drum Labs. He is betting all on two things: first, a new circuit that will make his Drummer

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Boy micros more powerful and salable than ever; second, an artificial intelligence program code-named Ariel. Yet there is a bug in the circuit, and Ariel stubbornly refuses to think.

Threatened by a disloyal treasurer and industrial espionage, he hires recently separated psychologist Linda Woods to help boot Ariel over the line. Meanwhile, his son is accessing Ariel from his bedroom terminal, playing games, feeding data, and copying files. A Japanese agent murders a night watchman, the treasurer sells out, systems crash, love blooms, and Ariel finally thinks. The story moves well and the action is generally believable. So are the people, and Bickham successfully enlists our sympathy for Harrington's trials. At the same time, Ariel develops in a way we can accept. Bickham has a good understanding of computers, artificial intelligence, and entrepreneurs.

Unfortunately, there are occasional slips. At one point Harrington arrives at the lab wearing work boots that look like they'd been slept in. One scene later, with no opportunity to change his footgear, he's wearing Pumas. But don't you mind that; I'm a disreputable quibbler, and the tale *is* good.

Speaking of artificial intelligence, you may wish to know more about what it's all about. In that case, GO TO F. David Peat's **Artificial Intelligence: How Machines Think**. It offers an excellent overview of the questions of computer thought and logic, problem-solving, vision, and movement, as well as expert systems and the use of natural language (plain English) to communicate with the machines. There is even some discussion of what it must mean to call a computer self-aware or self-conscious. And there is a good sense of how the field interconnects with many other areas of research. The author, apparently an Englishman, is well-read and articulate; he is also very optimistic about the future role of parallel processing (meaning, in part, the use of separate processors for separate functions).

However, you should be prepared to be distracted by endless typos and sloppy grammar. For instance, MIT's math program, MACSYMA, is consistently referred to as MACYSMA; sentences run into each other; and commas are widely absent. There are carelessly captioned illustrations. There are even a few careless errors—nerve cells do *not* have dendrites at the ends of their axions, or *axons*. The result is so consistently hard to read—"think thank" is one of those typos that stops you dead in your tracks—that it invites you to distrust it. And that is unfortunate. Treated more kindly, this timely book would have been far more valuable.

The theme of John Steakley's **Armor** is not entirely the obvious. The physical armor blazoned on the cover is there, yes. It is what makes soldier Felix virtually invincible against normal foes, a muscle-amplifying, weapon-bearing shell for flesh. It is also what makes his foes so hard to beat, for the buggers are insectile beings, the fists of a species that uses biological technology and assembles its soldiers from bins of organic parts as needed. Worse yet, their exoskeletal armor is nearly as tough as Felix's plasteel, and their strength is enough to crack soldiers from their suits like lobsters.

There is also more tenuous armor. When we meet Felix, he is without a past, and there are signs that he has willingly abandoned some high position. Highly competent, he is the sole survivor of mission after mission.

And then Steakley drops him in favor

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of Jack Crow, the hero who swiped the star-drive from aliens. Crow breaks loose from a bugger hive and takes refuge on a pirate ship. He agrees to help the pirates take over a research colony in return for a fortune recorded in the computer of an abandoned suit of soldier-armor. On the ground, he finds a world owned by one man and a research team with whom he can ally truly. He turns the armor over for study, and he watches as the chief researcher devises ways to read memory traces from its interior. We meet Felix again, for it is his suit, and we learn what happened to him and who he really is. And then the pirates attack.

In the course of the story we learn a great deal about the psychological armors that make Felix and Crow—and others—who they are. We learn —perhaps Steakley's major point—that we can read a person's armor in vivid detail, even when we cannot reach the person within. We learn that a violent, bloody story, apparently a gratuitous pandering to that notoriously human lust for blood, can be something very much more indeed.

Unfortunately, there are drawbacks. The pirates seem to have no excuse and indulge in precious little piracy. The buggers are that scifi bugaboo, giant ants. And the editing of this book too is decidedly poor—only well into the book are the buggers' "ectoskeletons" corrected to "exoskeletons."

The plusses, on the other hand, are enough to make the book well worth reading. When you do, wonder with me how much of the book's background, and even its themes, have been inspired by the author's experience, perhaps in Vietnam.

In *Heretics of Dune*, the Bene Gesserit wound up fleeing the wrath of the Honored Matres, power-mad, wicked versions of the BG witches spawned in the Scattering of the human species among the stars beyond the old empire. They made their seat on a new world, Chapterhouse, and seeded it with the sand trout that grow into the great desert worms and create deserts and the essential spice.

Now Frank Herbert brings us **Chapterhouse Dune**, sixth in the series. He shows us Chapterhouse a few decades later, becoming a desert world as the worms thrive under the watchful eye of Sheena, the girl who once talked to Shai-hulud. He shows us the Duncan Idaho of *Heretics*, imprisoned with Murbella, his Honored Matre mate, in a no-ship, invisible to those who see probabilities. He shows us Odrade, grown up to be chief of the Bene Gesserit. He gives us glimpses of the force, apparently born of the Bene Tleilax and its shape-changers, that sent the Honored Matres fleeing back to the empire's turf.

The story is simple. The Honored Matres are bent on the extermination of the Bene Gesserit. The Bene Gesserit is desperate to survive, and it pursues two main ploys. One is a new Scattering of its own, sending out Reverend Mothers, their minds packed with memories of all their peers, to find safe havens. The other is war, led by a child, the clone of the Bashar Miles Teg who had helped so greatly in *Heretics*. Yet the war is aimed less at destruction of the enemy than at conversion, as first shown clearly possible by Murbella's acceptance of Reverend Mother training.

The story is simple, but the interweavings of personalities and events are anything but simple, as usual with Herbert. The tale gathers momentum rapidly, and the climax would be entirely satisfying if it didn't leave too much

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unclear. But loose ends are another of Herbert's trademarks, and we can be confident that he will gather them up in still another chapter of the Dune epic. That chapter should, I expect, show us the good from which evil flees. It may add two goods to create a potent force for the maturation of humanity. More likely, perhaps, it will put the two goods in conflict.

In my review of *Heretics*, I said that Herbert was back in the groove, with a story far more absorbing than its immediate predecessors. He's still in that groove, folks. Enjoy.

For many years now, James White has been entertaining and stimulating us with his tales of Sector General, that vast, multispecies, interstellar hospital. Hero Conway has grown from trainee to Senior Physician, solving problems of communication and coexistence and treatment with dozens of strange aliens, while White has shown us the intricacies he imagines for a service-oriented, peaceful, yet exciting future way of life.

The one of White's imaginings that has always appealed to me is his answer to how you know to treat an alien with whom you are totally unfamiliar: You have read into your brain a tape made of the expertise of a medical expert from that alien's species. With the expertise, you acquire prejudices, sexual preferences, and motor programs; if you have two legs, and the expert has six, the result can be confusing, to say the least. If you are a Diagnostician who carries half a dozen such tapes at once, it's a wonder that you can function at all.

In **Star Healer**, Conway is promoted to Diagnostician. Pity the fellow. White's aim is to show us just how it must be to wear his shoes. Fortunately, he gives Conway a serendipitous aid. The story begins with Conway's visit to Goglesk, whose natives suffer from an adaptation to a prehistoric threat: When scared, they gang together in a mindless, interlocked mass that destroys homes, towns, and technology. Studying them, Conway inadvertently exchanges minds with a local healer. Later, he finds the talents of his guest peculiarly suited to dealing with the additional guests of a Diagnostician.

The Gogleskans want relief from their curse, but Conway cannot help. He is too busy with his new duties, which include coping with several more usual medical difficulties. Perhaps the next volume will return to this problem. I suspect that Conway will find a way of muting or frequency-shifting the distress cry that triggers the Gogleskan ganging reaction. I look forward to seeing whether I am right.

Enjoy this one.

Elizabeth Mitchell, late of *Analog*, now of Baen Books, comes into her own as editor of **Alien Stars**. The book holds three novelettes, all good to excellent. C. J. Cherryh tells us of a war that drags on and on because of the differing psychologies of humans and their enemy in "The Scapegoat." In "Seasons," Joe Haldeman gives us a team of anthropologists studying a species whose psychology changes drastically with time of year, from peaceable to implacable; it's not a happy story. Timothy Zahn tells us, in "Cordon Sanitaire," of another study team, confronted by a variety of subsapient ape that nevertheless wields advanced weaponry. The first two give us the grittiest realities, but the first and third offer the most thought. Haldeman seems content to show without explaining.

For Christmas (1984), I got David E. H. Jones's **The Inventions of Daeda-**

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lus: A Compendium of Plausible Schemes, drawn from Jones's perennial column in the British *New Scientist*. The book was published in 1982, so I bring you the word rather late, but the word is worth bringing. Jones's "schemes" are delights of fancy worthy of *Analog*'s own "Probability Zero" feature. Consider, for instance, the idea of a boat that uses a belt running over rollers to speed atop the water's surface; resistance would fall, for the belt moves backward, there is no movement *through* the water, and there is no wake.

I found it an interesting game to look for the little details Jones leaves out of his reasoning to make his schemes seem plausible. I found it even more interesting to note his wide-eyed surprise when he found, a year or so after a particular column, that someone had actually turned his brainstorm into reality. Believe it or not, Ripley my dear, that roller boat was actually being tested, within *months* of Jones's column, by both the US and the USSR!

You shouldn't have too much trouble laying hands on this one. Freeman seems to keep its books in print awhile.

Howard DeVore, Misfit Press (4705 Weddel, Dearborn, MI 48125), periodically updates his and Donald Franson's **A History of the Hugo, Nebula, and International Fantasy Awards**. The latest edition (maybe the twelfth, says DeVore) is now available; it's a compendium of a few short essays and lots of detailed lists of winners and nominees (even, for the Nebulas, of recommendations). Just the thing for anyone who wants to play the SF trivia game.

It's worth noting, very briefly, that Misfit also publishes a few other items. One is a short collection of Mike Resnick's short stories whose review was dropped, for reasons of space, from last October's column. For $3, you can order *Unauthorized Autobiographies and Other Curiosities*, published for Confusion 1983.

You might expect David Hartwell's **Age of Wonders** to be a book of personal reminiscence, covering his years of involvement with the SF field, perhaps even chronicling the events that severed him and his SF line from Pocket Books.

If so, you will remain unsatisfied. In Hartwell's own words, his book "is an outsider's guidebook and road map through the world of science fiction, pointing out the historical monuments, backyards follies, highways, and back streets of the SF community—a tour of main events and sideshows, and a running commentary on why the SF world is the way it is." In this it succeeds fairly well, although most of the material on fans and fandom is less thorough and enticing than I have seen elsewhere; I suspect a certain degree of condescension. The book is most valuable for its discussion of the whole issue of wonder, or awe, that makes SF what it is and defines its appeal, and then for its analysis of what makes good SF good. There is a strong link, Hartwell says, to religion and myth, and the field's ghetto position may be best compared to the declassé status of drama in the Elizabethan age of poetry.

Looking at trends, Hartwell predicts a possible Fantasy War for the minds and pocketbooks of readers, continued popularity of sci-fi (*not* SF) for at least the next decade, further penetration of SF imagery into our cultural consciousness. And we should "get set for a lot more SF, because our world is still changing fast and SF is the only liter-

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ature that is well prepared to respond to change."

I found the book interesting, but I did wish it were something else—more comprehensive, perhaps, more historical, more personal, certainly longer, and maybe more consistently profound. I am left with the nagging question of just what the ideal SF overview should be like, and who should write it. Unfortunately, there may be no broadly acceptable answers here, for SF is a bloodily partisan field, arousing both loyalties and disputes in endless variety. Most of the people who come to mind as potential surveyors are too closely identified with their own particular viewpoints. Hartwell may in fact be one of the least so tainted, and hence he may in fact be the best possible surveyor of the field. Certainly he has done an adequate job, though I doubt he will be much read by the outsiders he professes to address. It is writers, readers, reviewers, critics, many of them fans, who will buy and read his book. May they be many. ■

● Our September cover story is the first for a writer rapidly establishing himself as a new *Analog* favorite: Eric G. Iverson. In recent years the term "Native American" has come into widespread use to designate those peoples who already resided in the Americas when the first Caucasians arrived from Europe. The term is a little misleading because the first "Native Americans" were immigrants too, probably walking across the Bering Strait from Asia when low sea levels exposed a land bridge there; they just got here earlier. What if they hadn't? If it's true that many large prehistoric mammals became extinct under the weapons of early *Homo sapiens,* they might have survived to the present in the absence of those weapons. And *Homo erectus* could have walked across and flourished, yet not been quite clever enough to hunt mammoths and sabertooths to extinction. Eric Iverson's "Vilest Beast" introduces us to an alternate history in which it happened that way—a world not *too* dissimilar to ours, but one in which the first English colonists found the land occupied not by "Indians" but by *Homo erectus.* Which might have far-reaching effects on both thoughts and deeds of the centuries to come. . . .

We'll also have the newest novella in Gordon R. Dickson's "Pilgrim" series, as well as Part III of Timothy Zahn's *Spinneret.*

IN TIMES TO COME

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brass tacks

Dear Stan,

I enjoyed your "Kelvin Throop" issue. I enjoyed the year. Keep up the good work.

I want to comment on G. Harry Stine's Alternate View from the December issue. I don't know how the *World Almanac Book of Facts* counts armed forces (perhaps only Army troops)—I do know that his Table II is misleading. U.S. military manpower is currently 2.14 million and U.S.S.R. military manpower is currently 5.05 million (up from 2.05 M and 3.66 M in 1980, respectively). Thus the entry for the U.S. in Table II should more properly be 9.3 and that for the U.S.S.R. should be 18.7. The other numbers in the table must be suspect as well.

This does not address the question of whether these numbers are relevant, nor the question of whether we should do it because our forefathers did it, nor the question of whether it is *desirable* to have one person in ten in a country's armed force. It is well known that when one has an expensive armed force (or an expensive weapon), there is a great temptation to use it. Both the U.S., which has used armed force in foreign countries 215 times since WWII, and the U.S.S.R., with 115 interventions to its "credit" since WWII, bear witness to this.

The arms race seems to cause the arms race. Each side sees the other as a focus of stubborn opposition, if not "evil." Each side has to keep up with the Joneses. Each side, in response to "provocation" by the other, throws money at the problem. In both countries this money surely could be spent to better purpose. Do we want to do something just because they do it? Does it matter for us if ethics and morality play no part of any import in national policy?

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Or even, will throwing money at the problem ultimately solve anything?

I have no easy answers. There are no easy questions, despite the attempts of some politicians to cast them in terms of good and evil. It is dangerous to simplify the issues. We may come to believe that there are simple answers. While this may make us feel good, it may lead to serious errors.

Stine is right to raise questions; he should have paid more care to the context. Perhaps he'd care to revise his perspective in view of the revised numbers.

GORDON J. AUBRECHT II

There were also a couple of typos, for which we apologize—e.g., the ratio for Japan is correct, but the raw numbers are for Libya.

Dear Stan,

In re your editorial, "Guilty Until Proven Innocent" (December, '84): Your point about harrassment by petty bureaucrats is well taken. While no one has ever tried to validate a luggage claim check of mine, there have been many other instances where the guilt before innocence presumption has held true. (All of you who have ever tried to cash a perfectly good check at an unfamiliar bank and been made to feel like a felon, raise your hands.)

All this can be bad enough in ordinary circumstances. In times and places where security precautions are necessary for the safety of all concerned, the required probing can be intolerable if carried out with the wrong attitude on the part of the inspector. (I'm not even going to try to touch the parallel question of how much liberty is one willing to lose for the price of safety) In this connection, I would like to relate an incident that occured to me, or rather, near me recently.

Last September, I took a trip to visit my relatives in Northern Ireland. Since you can't fly direct from Los Angeles to Belfast, you have to take a local carrier from Heathrow. In order to get into that carrier's boarding area, you must pass through the usual metal detector, have *all* of your luggage X-rayed, submit to a careful inspection of any carry-on luggage (which is requested to be kept at a minimum), and every passenger must be patted down by the security people. (Incidentally, I was amused to note that this boarding area was well away from all the other airport buildings.)

I think you'll probably agree that these measures are not excessive, considering the circumstances. Furthermore, they were carried out courteously, and with the underlying British attitude of Let's-make-the-best-of-a-bad-situation-mate, so there was nothing overwhelmingly bad about it.

Ahead of me there was a woman who had in her hand luggage about half a dozen gift-wrapped boxes, small ones, presents for friends and relatives. Unfortunately, they had to be inspected. However, the security man carefully undid the tape at each end of each package, slipped out the box, looked inside, and replaced each one in its wrapping, without messing anything up. This consideration, in the commission of a potentially odious task, demonstrated to me an attitude of innocence-before-guilt which I found rather refreshing.

The moral of the story is that courtesy and an even-handed application of the rules can make up for a lot. (The bigger moral is that people shouldn't try to blow each other up.) Of course, courtesy can't always make up for everything. I'll leave others to hash that over.

Keep up the good work.

BRIAN F. SWISHER

Burbank, CA

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Dear Mr. Schmidt,

I read your editorial in the December 1984 issue and it struck home a vicious blow. If you think submitting to a search at an airport, or having their security personnel compare baggage claim checks is a violation of your rights, then you should thank your lucky stars you are a magazine editor and not a member of our "glorious military." I am, and have been for seven years. However, after my present commitment expires, I no longer will be!

We in the military are routinely subjected to automobile searches. We are presumed guilty of having stolen government property, unless such property isn't found on our person, in our car, or in our homes. We are routinely subjected to urinalysis, and our cars stopped and sniffed by trained dogs on the assumption that unless we are found to be innocent, we must be guilty of taking drugs. Any time we go to the hospital and a blood or urine sample is taken it is routinely examined for any drug traces that have not been prescribed.

I, as an honest person and one who does not take drugs illegally, find these sort of practices extremely humiliating. However, if this point of view is expressed we are told: "if you're doing nothing wrong, you have nothing to hide and nothing to fear." BULLSHIT!!

There is so MUCH fear we voluntarily take our cars (they must have just been recently purchased in this instance), to have a "courtesy check" done on it for drugs—SO THAT WE WILL HAVE A CHANCE TO CLEAR IT AND NOT BE ACCUSED DURING THE NEXT SEARCH! If we sponsor anyone to come on base, we, the military members, are held responsible AND PROSECUTED for any wrongdoing on their part. This includes our dependents, and can be for anything from running a red light, speeding, bouncing a check, to the illegal use of drugs.

What is even worse, a military member can be prosecuted and given a dishonorable discharge, ruining any future career chances as a civilian, simply if another person says "I saw them do it." EVEN WHEN THERE IS ABSOLUTELY NO EVIDENCE TO BACK THE STATEMENT UP!

We are subjected to this because supposedly we VOLUNTEERED for it when taking our oath.

I think the saddest thing I am going to say and do is that I will not sign my name in case this letter gets printed. It truly is a sad state when an American citizen can expect to fear reprisals for excercising free speech!

AN ARDENT SCIENCE FICTION READER

Dear Stan:

In response to the letters I've received as a result of my science fact article, "The Coanda Effect" (July 1984 issue):

Dr. Coanda didn't publish much. A few obscure and generally unusable references appear in the French technical literature. There was an article on fluidic control devices utilizing Coanda Effect in the December 1964 issue of *Scientific American*. The U.S. Army Diamond Laboratories has some data as a result of their fluidics developments in the 1960s. There have been a few popular magazine articles dating from the 1930s to the mid-1950s in the United States, Great Britain, and France. The most lucrative field for a literature search is the United States Patent Office where Coanda has a large patent file. And that's about it.

Most of what's available is misleading or highly specialized. Therefore, I wrote the article because none of the

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empirical expertise passed on to me by Dr. Coanda had been published anywhere. It seemed a shame to allow it to lie fallow until someone else re-invented it. In the article, I gave enough information to permit any competent engineer or technologist to proceed. There appears to be a growing trend of fear to experiment among technically-trained people; they seem to want to base everything upon computer modeling. My advice to those who are interested: Using the basic concepts I presented in the article from the inventor of the Coanda Effect himself (and filtered only once through me, making it only second generation data), get out there and build Coanda Effect devices! You'll be amazed at how non-critical they are!

G. HARRY STINE

Dear Stan:

I am baffled by Tom Easton's comments about Baen Books in the March 1985 Reference Library. First he bemoans the loss of Pocket's Timescape SF line, then calls us to account for publishing books that "would have been right at home on the Timescape list." And to tie it all up he calls into question our relationship with our national distributor, saying "I wonder if Pocket really knows what is going on?"

What is Tom's point? The several titles transferred to us from the Timescape inventory were published with the full approval of Pocket and the authors involved, as anyone knows who has kept abreast of the matter. Some we took from manuscript form. All carry cover artwork we commissioned and copy we wrote. The final results, in most cases, we consider to be just as much "Baen Books" as anything we obtained in the usual way.

Interestingly enough, of the five Baen titles covered in the March issue, the three Tom recommends favorably were original Baen purchases. The other two were Timescape books.

BETSY MITCHELL
Senior Editor, Baen Books

Dear Dr. Schmidt (and Mr. Delaney),

This letter comes a bit late, but as a graduate student (clinical psychology), I save all my magazine reading until the semester's end. I am writing in reference to Joseph Delaney's "Thus Began the Death of Dreams" (November 1984).

I read it last week, and found it disturbing—probably should have written this letter then, but I looked at the date and shrugged it off. While reading some developmental psychology this evening (a discussion of the development of a sense of industry and of intimacy), I again thought of Mr. Delaney's story, and again felt disturbed.

I cannot let it pass without comment.

Mr. Delaney's treatment of the idea of a sleepless population does a grave disservice to humanity and society (distinguishing here the individual and the culture).

Most people would not give up their homes, their families, their hobbies and recreations simply because they no longer spend long stretches of time unconscious.

Humans are territorial creatures. Home is more than a place to sleep. Home is personal space. A place to be alone, or in the company of those with whom you choose to be. A place to keep those possessions which hold memories of a life touched by experiences of people and places. A place to store collections of science fiction magazines.

A lack of homes to live in implies a dissolution of the institution of the family. People do not marry simply to avoid the need for an electric blanket. What do you do if your spouse works in a

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different establishment? Throw up your hands and say, "Oh well, so much for him?" What do you do with your children? Pat them on the head and send them off to 24-hour nurseries and schools? Maybe see them some day if they grow up and work for your company?

But then, if people spend all their time working, there won't be any time for sex. There won't be any children born, and we'll die out in one generation. That might be a blessing—Mr. Delaney's world doesn't sound like much fun!

None of the story's characters seem to have developed beyond adolescence. Only same-sex relationships seem to be considered. Adult intimacy is seen nowhere in the sweeping view of the simplistic world we are shown. I am not talking of sex—the equation of sex with intimacy is an adolescent confusion which is modified by experience and growth. The readership of *Analog* is not wholly adolescent. And even for those pre-adults who do read the magazine, it is unfair to withhold from them the opportunity to study adults as adults, to deny them a glimpse of what lies ahead, of role models to consider.

Mr. Delaney also has ignored the empirical evidence on sleep-deprivation. It is a fact that people who are deprived of sleep for long periods of time experience hallucinations. It is a fact that when people are allowed to sleep, but not to dream (ie. if they are awakened at the beginning of each dream period), when they are once again left to sleep undisturbed, they will have a greater number of dreaming periods in the same amount of time asleep, as if to catch up on lost dreams. Sleep and dreams seem to play a non-trivial role in both physical and mental health. A science fiction story dealing with sleep deprivation must consider (and provide at least a brief explanation of the circumvention of) these facts.

I will refrain from listing the many details in the story which jarred my sensibilities, and contributed to my inability to suspend disbelief. Point-by-point refutation would be quibbling—and this letter would end up longer than the original story.

A "cure" for sleep is an interesting idea for a story. Unfortunately, this one left me entirely dissatisfied.

ABIGAIL F. STRICHARTZ

Amherst, NY

When you change one essential characteristic, you're likely to change others in an interconnected way. When people start speculating about things like that, they're likely to come up with quite different ideas—which is one of the things that makes this field fun.

It sounds as if you're just itching to write your *version of how it might happen. Well*—Analog *is always looking for good new stories and writers. If you think you can do better, give it a try and let me see it!* ■

● The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve.

Eugene Wigner

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a calendar of analog upcoming events

19-22 July
ALBACON 84 (Scots SF conference) at Central Hotel, Glasgow, Scotland. Guests of Honor—Harlan Ellison and Anne McCaffrey. Registration—L8 (attending), L5 (supporting); all funds to be remitted as Sterling. Info: Vincent J. Docherty, 20 Hillington Gardens, Cardonald, Glasgow G52 2TP, Scotland, United Kingdom (use airmail).

26-28 July
RIVERCON (Louisville area SF conference) at the Galt House, Louisville, Ky. Guest of Honor—George R.R. Martin. Fan Guest of Honor—John Millard, TM—Mike Glicksohn. The usual plus the river cruise (Belle of Louisville). Registration—$12 until 15 July, $16 thereafter. Banquet $17. Info: Rivercon X, Box 58009, Louisville KY 40258.

2-4 August
ATLANTA FANTASY FAIR 11 (Southeastern SF/Fantasy conference) at Omni Hotel and Georgia World Congress Center, Atlanta, Ga. Short story competition; graphic story competition, amateur film festival, art show, costume contest, etc. Registration—$21 until 30 June (club and family discounts available), $28 at the door. Info: Atlanta Fantasy Fair, Box 566, Marietta GA 30061 (enclose S.A.S.E.) (404) 425-8095.

2-4 August
OMACON 5 (Midwestern area SF conference) at Holiday Inn-Holidome, Omaha, Nebr. Guest of Honor—C.J. Cherryh, Fan Guest of Honor—Bjo Trimble, Artist Guest of Honor—Robert Daniels, Jr. Games—role playing, board. Video rooms, art show, banquet, etc. Registration—$15 until 15 July, $18 at the door. Info: Omacon 5, Box 37654, Omaha NE 68137 (include S.A.S.E.)

2-4 August
AUGUST PARTY (Star Trek oriented conference) at Hyatt Regency, Bethesda, Md. Registration—$11 until 26 May 1985, $15 thereafter. Info: August Party, Box 335, Arnold MD 21012.

23-25 August
BABELCON 7 (Michigander SF conference) at Airport Hilton, Grand Rapids, Mich. Guest of Honor—Phil Foglio. Registration—$12 until 1 June, $15 thereafter. Info: BabelCon VII, c/o Cathy Van Lopik, 3040 Byron Center #3, Wyoming MI 49509.

30 August-2 September
MORE EASTLY CON (NYC area SF conference) at Sheraton LaGuardia, Queens, N.Y. Registration $23.50 until 7 August 1985. Info: Devra Langsam, 627 East 8th Street, Brooklyn NY 11218.

30 August-2 September 1985
NASFiC 1985 (North American SF Convention, officially The First Occasional Lone Star SF Convention & Chili Cook-off) at the Hyatt Regency Austin and Palmer Auditorium, Austin, Texas. Guest of Honor—Jack Vance, Artist Guest of Honor—Richard Powers, Fan Guest of Honor—Joanne Burger, TM—Chad Oliver. Registration—attending $45 in advance, more at the door; supporting—$15. Info: NASFiC, Box 9612, Austin TX 78766.

—Anthony Lewis

Items for the Calendar should be sent to the Editorial Offices six months in advance of the event.

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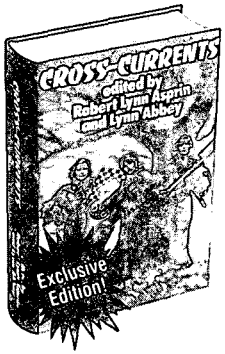

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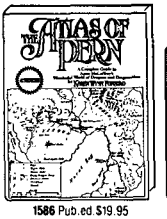

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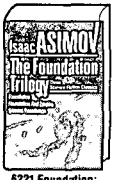

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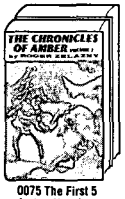

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